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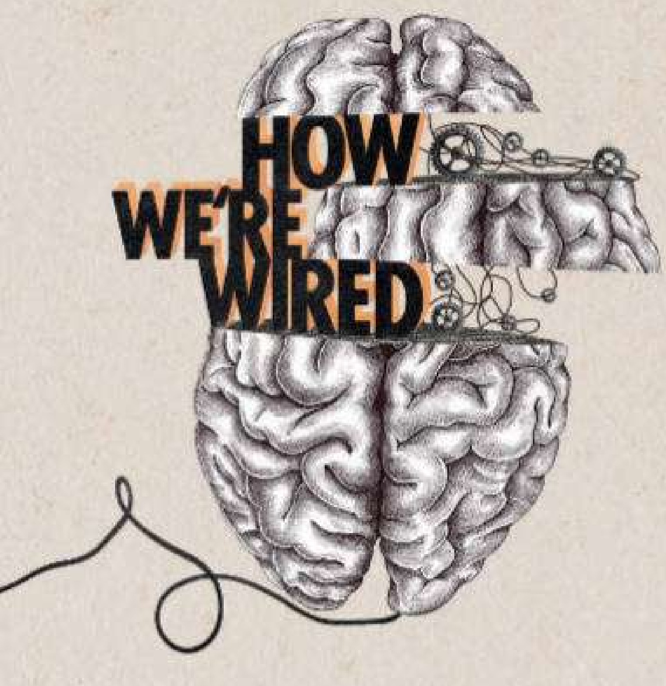

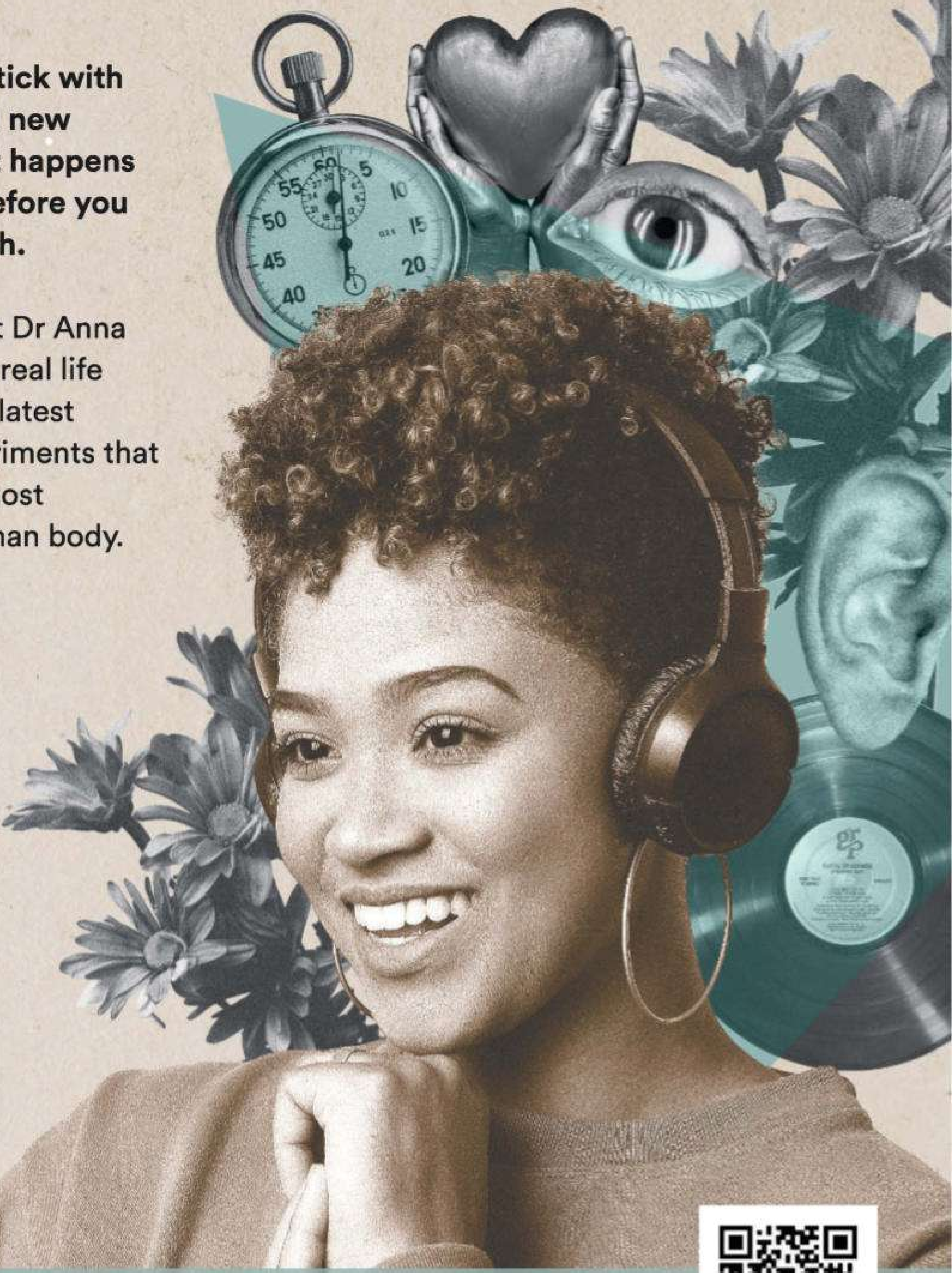

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New Scientist

POWER UP YOUR BRAIN

A radical new theory on how to reverse cognitive decline

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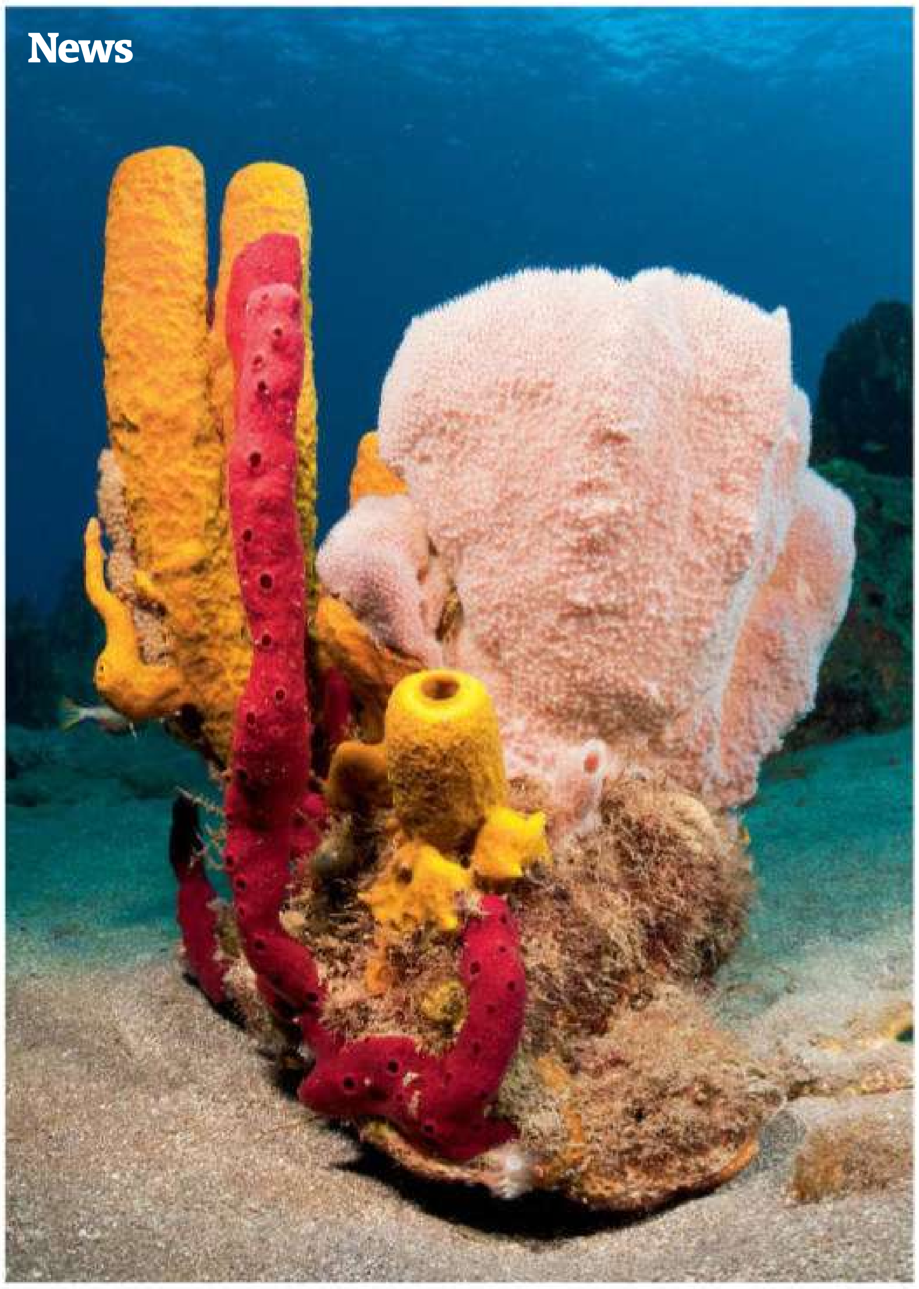

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Virtual event

Fermilab: Solving the mysteries of matter and energy, space and time

Join Fermilab senior scientist Don Lincoln as he explains what the particle physics facility in Illinois has taught us about our universe. Major discoveries made at the lab include the top and bottom quarks – and its future work might be critical for a "theory of everything". Online on 4 April at 6pm BST/1pm EDT. Early booking tickets are £14.

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Tour

CERN and Mont Blanc: Dark and frozen matter in Switzerland and France

Mix physics and glaciology on this unique experience. Particle physicist Darren Price will show you around CERN, home of the Large Hadron Collider, then you will travel to Chamonix to see the Mer de Glace glacier. The six-day tour starts on 2 May and costs £2498.

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Podcast

Weekly

The idea that viruses can trigger chronic health conditions is gaining ground – and the team explores the role they might play in chronic fatigue syndrome and fibromyalgia. Podcast editor Rowan Hooper talks to Jim Haywood at the University of Exeter about geoengineering. Plus, our understanding of how galaxies form could be wrong.

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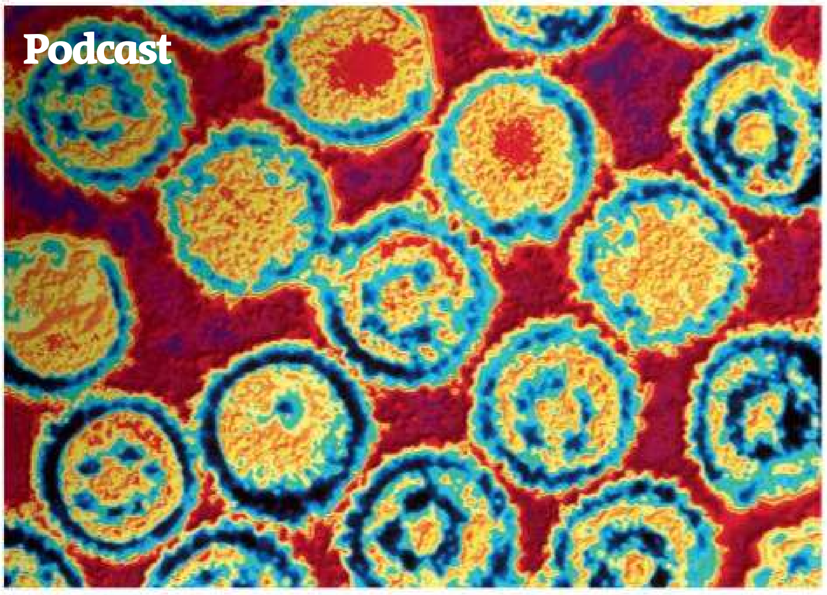

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Viral problem Is Epstein-Barr virus a factor in chronic conditions?

MARKUS SEIDEL/GETTY IMAGES

Alpine views The Mer de Glace glacier in France

Video

Sea monsters explained

On our YouTube channel this week, there is video footage of humpback whales holding their bodies vertically with their mouths wide open at the sea surface to catch fish. The unusual feeding technique, first seen by scientists in 2011, might also have been documented in Old Norse manuscripts, which show sea monsters feeding in the same way.

youtube.com/newscientist

Newsletter

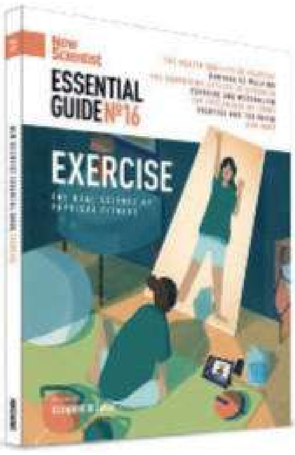
Fix the Planet

Many homes in England aren't well insulated, but change is on the way, writes environment reporter Madeleine Cuff. The Future Homes Standard comes into force in 2025, and it will require that homes have a 75 to 80 per cent reduction in carbon emissions when compared with homes built today.

newscientist.com/fix-the-planet

Newsletter

> **"A 'Future Home' with an array of green gadgets could have energy bills of just £11 a year"**



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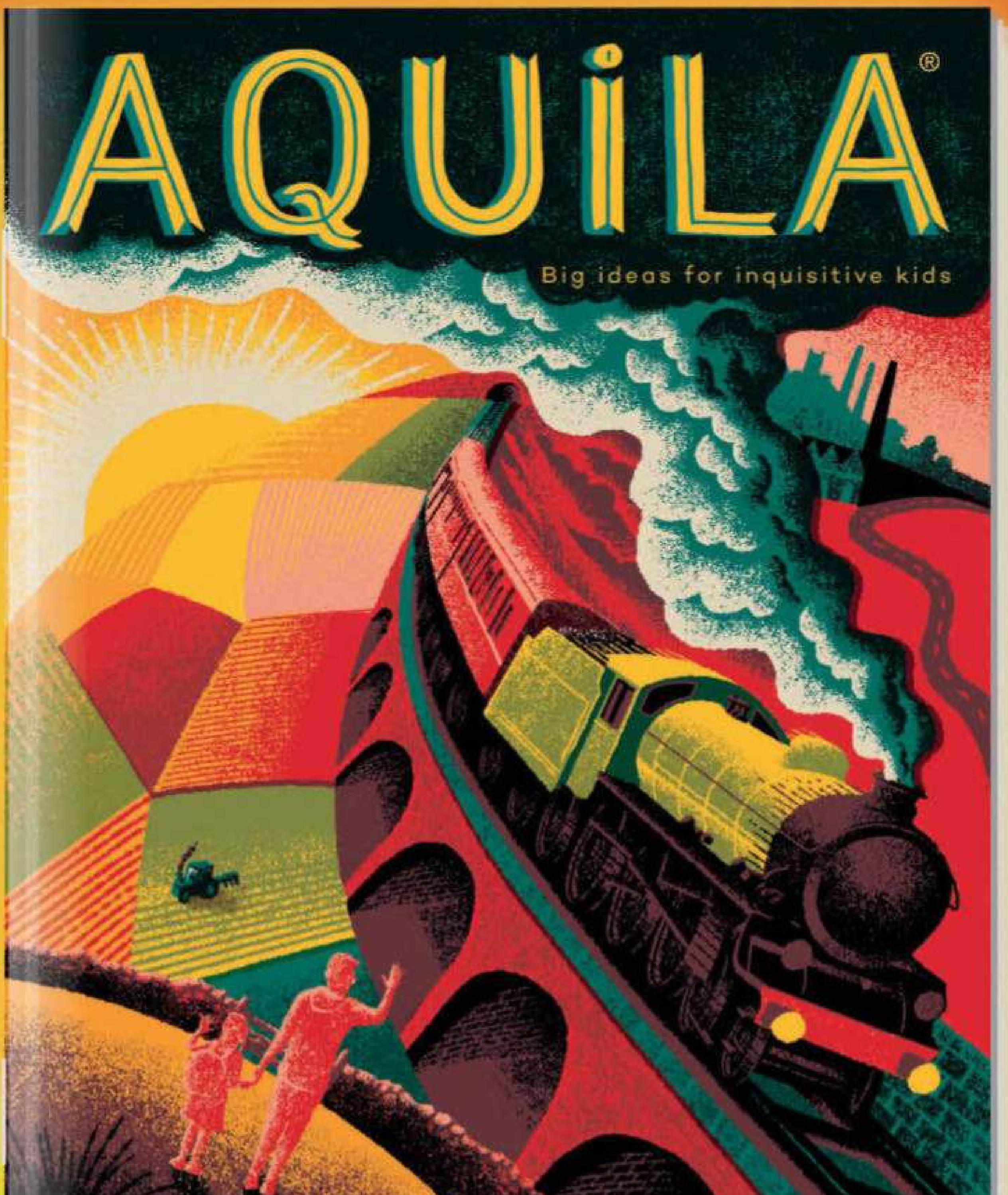

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Brain boost

A "grand unifying theory" of brain disease deserves our cautious respect

HAS the cause of brain degeneration been hiding in plain sight? More than 40 years ago, scientists noticed differences in the mitochondria of people with Alzheimer's disease. These cellular power stations, which pump out the energy necessary for normal cognitive function, were less abundant in the brains of people with Alzheimer's, and those mitochondria that remained appeared to be misshapen.

Despite these intriguing findings, scientists remained focused on the now infamous amyloid theory of Alzheimer's, in which cellular debris called plaques and tangles were thought to underlie the condition. However, decades of failed trials have sent researchers back to the drawing board – where mitochondria have been given another chance at centre stage.

And what a performance they are giving. A wealth of new evidence suggests that mitochondrial problems may indeed be the root cause of not only Alzheimer's, but many other conditions, including Parkinson's, Huntington's and Lou Gehrig's disease (see page 38).

> "Mitochondria may be the root cause of not only Alzheimer's, but many other conditions"

It seems an energy crisis in the brain, caused by malfunctioning mitochondria, prevents the growth and maintenance of brain cells and contributes to a build-up of toxic byproducts that exacerbate the cells' bad health and play a part in their untimely death.

Of course, the billions of dollars poured into those failed amyloid trials should highlight the need for caution when it comes to any "grand unifying theory" of brain disease. But this idea does have some tantalising advantages. Many strands of research support it, including brain imaging, cellular experiments and long-term studies. It also provides an elegant explanation as to why so many genetic and environmental factors can amplify your risk of brain decay, since they all contribute to energy dysfunction.

After decades of dead ends, any new avenue of exploration that brings hope to people with these devastating conditions is worth some (cautious) excitement, and we will be eagerly following its progress. ▮

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New Scientist is published weekly by New Scientist Ltd. ISSN 0262 4079. New Scientist (Online) ISSN 2059 5387. Registered at the Post Office as a newspaper and printed in England by Precision Colour Printing Ltd

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Environment

Golden state snowed under

Robert Hallmark, seen here clearing snow at his home in San Bernardino, California, on 1 March, says the state's recent snowstorm is the worst he has seen in more than 30 years of living there. As *New Scientist* went to press, residents in the state's southern mountain towns were still digging themselves out, after the blizzard left them unable to leave their homes.

DAVID MCNEW/GETTY IMAGES

Pollution

Swimming in murky waters

SAVE BRITAIN'S RIVERS

More rivers in England could soon be designated as bathing waters, but granting this status does little to identify or clean up pollution, finds **Jason Arunn Murugesu**

PAUL ELLIS/AFP VIA GETTY IMAGES

THERE are close to 1500 rivers in the UK, but just two stretches have been officially approved as swimming destinations – and even these are currently too polluted to use safely. While campaigners hope that other rivers will soon receive this "bathing status" designation, some fear the label is misleading, as there are few requirements to clean up pollution that can harm health and the local ecology.

Environmental matters are devolved in the UK, meaning the UK government oversees bathing waters in England, while Scotland, Wales and Northern Ireland govern their own affairs.

> "Just because it is safe to swim in a river does not mean it cannot still be polluted"

More than 400 bathing waters in England are tested by the UK's Environment Agency (EA) for levels of *Escherichia coli*, which causes diarrhoea, and intestinal enterococci, which are linked to urinary tract infections.

These tests occur 20 times at each site during the "bathing season" of mid-May to the end of September. Most are beaches, with just two stretches of river: the Ilkley bathing site on the river Wharfe in West Yorkshire and a stretch of the Thames in Oxford. No other UK nation has designated bathing rivers.

Based on its measurements, the EA categorises bathing waters as either excellent, good, sufficient or poor. Last year, 93 per cent were deemed excellent or good, but the two rivers were rated poor. Swimming is still permitted in them, but officials have had to put up signs advising people against doing so.

Part of the problem is that applications to grant bathing status don't require any water quality test, with tests only taking place once the status has been given. Given the generally poor state of England's rivers, newly granted rivers are likely to be in poor health. In fact, the sole requirement, set by the UK Department for Environment, Food and Rural Affairs, is that the water has "a large number of bathers in relation to any infrastructure or facilities that are provided". In other words, the water can receive bathing status even if people are swimming in pollution. *New Scientist* asked the EA why it doesn't test for other pollutants, but it declined to comment.

Richard Tyler at the Save the Wye coalition, a campaign group aimed at improving the water quality of the UK's fourth longest river, says he fears the general public don't understand the distinction between a river's bathing status and its ecological status. "Just because it is safe to swim in a river does not mean it cannot still be polluted," he says.

Cleaning rivers takes time. Ilkley only gained bathing status in 2020, the first stretch of English river to do so, with the Thames in Oxford following in 2022. The poor state of these rivers is probably due to sewage discharges and pollutants from farms allowing bacteria to flourish, says Alistair Boxall at the University of York, UK.

Creating accountability

Ruth Leach is leading a campaign to get bathing status for a stretch of the river Deben, Suffolk, in the hope that it will be monitored and cleaned by the EA and Anglian Water, the firm responsible for wastewater treatment in the region. "It's about creating some accountability and opening water firms up to scrutiny," she says.

Anglian Water says it supports the campaign and, after speaking to Leach, it is testing the Deben once a week for *E. coli* and intestinal enterococci levels. "As part of our Get River Positive programme, we've pledged to make sure our operations will not be the reason for poor river health," a spokesperson said. *New Scientist* understands the EA is expected to make a decision on the Deben's status in time for this year's bathing season.

But Tyler says that simply measuring bacteria in a water body isn't sufficient. For example, phosphorus, which can leak from local farms, has little direct impact on human health and is rarely monitored in bathing waters. Yet it is a major issue for rivers, as it leads to increased algal growth. This can lower oxygen levels in rivers, harming local animal and plant life, says Tyler, and some algae can be dangerous for people.

Boxall says the EA also doesn't monitor for domestic pollutants, such as medicines and shampoos, which can end up in rivers. "We've done research that shows that ibuprofen levels in half of England's rivers may be harming fish health," he says.

Rivers in highly populated urban areas of England also appear to contain high levels of antibiotics, says Boxall, but there is no requirement to test bathing waters for their presence. "There is some suspicion that river systems could be contributing to the antimicrobial resistance crisis," he says. "But there are no limits on how much antibiotics can be emitted from wastewater treatment works into rivers."

0

Number of quality tests required to designate a bathing water

Some river campaigners have

The river Wharfe in Ilkley was England's first bathing river

moved away from seeking bathing status. Susan Buckingham at the Friends of the Cam says her team didn't back moves by other local activists to seek bathing status for part of the river Cam in Cambridge. "Our reason for being is to make rivers clean and to get freely flowing rivers, but actually having a bathing quality designation is sort of meaningless," she says.

When asked whether people can confidently swim in rivers with bathing status, the EA declined to comment. But there is some evidence that designating bathing waters and monitoring them for bacteria makes them safer for humans to swim in. Nick Voulvoulis at Imperial College London points out that many of England's coastal bathing waters were in a far worse state several decades ago. According to the EA, just 28 per cent of bathing waters met the highest standards in force in the 1990s. Today, the figure is 72 per cent – though it is hard to make direct comparisons, as 2015 saw stricter guidelines introduced.

Ensuring that rivers with bathing status have lower *E. coli* and intestinal enterococci levels is likely to require the installation of more wastewater treatment facilities, says Voulvoulis. Such plants are expensive, but this is how water quality at coastal sites was improved, he says. Last year, ultraviolet disinfection measures were added to the wastewater plant near the Ilkley bathing spot, with the hope that it will lower the levels of microbes released by the plant into the river Wharfe.

To make rivers truly pollutant free, bathing status can only be the start, says Boxall. Taking pharmaceutical pollution as an example, he notes that new cosmetics often aren't rigorously tested for their effect in water bodies. "We could redesign those products to make them safer for the marine environment," he says.

Meanwhile, Tyler argues that the best way of solving the Wye's phosphorus problem would be to deal with chicken manure from nearby farms, which last year were found to be one of the main sources of phosphate pollution in the river.

Each polluted river in England is likely to have a unique set of problems, so each will require a unique set of solutions. But Jamie Woodward at the University of Manchester, UK, argues that to solve any of these problems, we first need detailed river-monitoring schemes, beyond a simple focus on bacteria. "In environmental stewardship terms, I would say we're a failed state right now," he says. "We don't even have the data to say how bad we actually are." ▮

Space

Missing matter found, but now there's too much

Leah Crane

MANY large galaxies were long thought to be missing a huge proportion of matter. Now it has been found, but that is raising new questions.

Observations over the course of the past decade have shown that galaxies about the size of the Milky Way appear to have far less baryonic matter – meaning normal, not dark, matter – than we expect. This is based on the ratio of dark matter to regular matter in the universe, which suggests that galactic discs only had about 20 per cent of the baryonic matter they should. Studies later found about half of that missing matter in clouds around the galaxies called the cool circumgalactic medium, but the other half remained elusive.

Now, Fabrizio Nicastro at the National Institute for Astrophysics in Italy and his colleagues have used data on three galaxies from the XMM-Newton space telescope and the Chandra X-ray Observatory to find the rest of their missing matter – and there may actually be far too much.

By "stacking" observations of the three galaxies together to measure the light of all three, instead of one at a time, the researchers found signs that mingling with the cold gas of the circumgalactic medium was hotter gas – a mass equal to hundreds of billions of times the mass of the sun (arXiv, doi.org/jzr8). "The mass we estimate is sufficient to explain the missing mass in galaxies," says Nicastro.

Spiral galaxies like M99 may be home to missing matter

ESA/HUBBLE & NASA, M. KASLIWAL

There is just one problem: the matter shouldn't be thought of as missing at all. Simulations of young galaxies show that powerful winds created by energetic processes like star formation and supernovae should have hurled much of the baryonic matter out of these galaxies when they were young. So, they were born with the expected amount of matter, and then it was ejected.

But that means the "missing" matter should be long gone – not hanging around in the circumgalactic medium. "We [thought] these baryons really should be missing, they should have been blown out of the galaxy," says Vikram Ravi at the California Institute of Technology. "From that perspective, it's an amazing result if it holds up." If the missing matter really is there, we will have to rethink how galaxies work on a huge scale.

First, these results will have to be confirmed. Data processing and interpretation tends to smooth things out, so a more precise model of how this matter is distributed could change the amount we think is there. To do wider studies of the circumgalactic medium, we need new telescopes, says Nicastro. It could take a decade or more before these are ready to unravel the mystery of the not-so-missing matter. ▮

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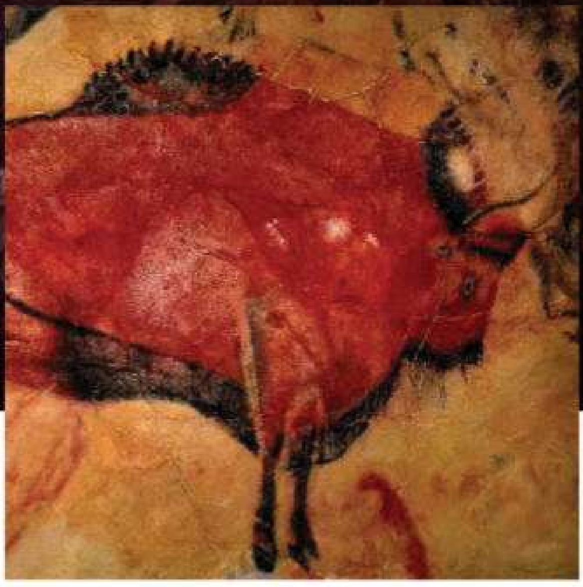

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Briefing High seas treaty

Deal struck to conserve oceans

Nations have agreed on a framework for protecting marine life in international waters for the first time, reports **Madeleine Cuff**

AFTER a decade of negotiations and a final two-week marathon of round-the-clock talks, countries around the world have agreed a new treaty to protect the high seas.

The agreement, struck late on 4 March in New York, establishes a legal framework that will finally allow countries to designate international waters as protected areas for marine life, if agreed by consensus.

But although Greenpeace welcomed the news as a "historic day for conservation", campaigners warned it marked only the start of a long journey to ensure the world's oceans are adequately protected for future generations.

What are the high seas?

The "high seas" refers to oceans that lie in international waters, meaning they aren't subject to any rules or regulations set by national governments. About two-thirds of the world's oceans fall into this category, covering half the planet in total. Few legal protections exist to govern activity on the high seas, particularly where environmental issues are concerned.

What is the high seas treaty?

Formally known as the Biodiversity Beyond National Jurisdiction treaty, the agreement will provide the first legal framework to apply environmental protections to the high seas.

Nations have been discussing this treaty since 2004 and, in the past year alone, have tried three times to get the agreement over the line.

But the talks have proved contentious. Nations have long argued over how to split the benefits of genetic resources in international waters, which can prove lucrative for pharmaceutical and cosmetics industries. Funding and fishing rights were also major sticking points.

What does the treaty achieve?

One of the most critical elements of the document is its provision to allow the creation of international marine protected areas, where activities such as industrial fishing or deep-sea mining could be restricted. The move is seen as vital for enabling the world to meet the goal to protect 30 per cent of the world's land and sea by 2030, which was agreed at the COP15 biodiversity summit last year.

The treaty also includes a plan to overhaul environmental impact assessments, which calculate the potential damage of human activities on the high seas. Under the treaty, all nations will need to follow consistent ground rules for carrying out these assessments.

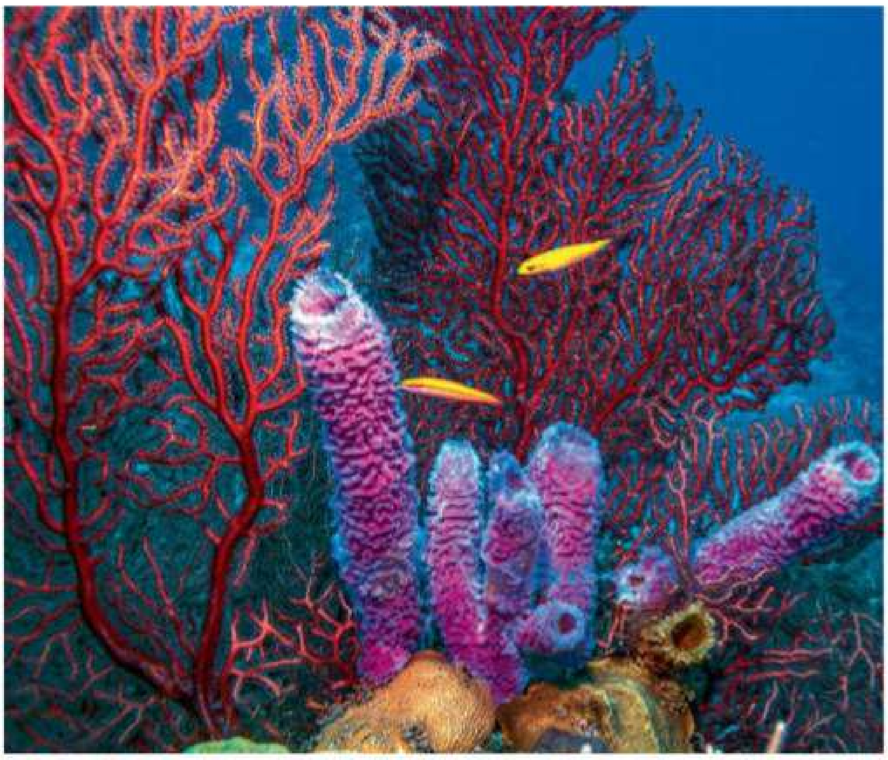
There are provisions to share the benefits of genetic materials from the oceans, and regular COP summits will take place to ensure the treaty is being adequately enforced.

What happens next?

Reaching agreement on the text of the treaty is a major breakthrough, but it is only the start of a long process of ratification and implementation.

The treaty needs to be formally adopted by member states, then ratified by at least 60 countries before it will enter force. Similar international treaties, such as the Paris climate agreement, took almost a year to be signed and ratified.

There will also be further questions to iron out in subsequent meetings, such as how marine protected areas will be managed, connected and enforced. ■



JOHN A. ANDERSON/ISTOCKPHOTO/GETTY IMAGES

Some corals, such as the deepwater sea fan, are found in the high seas

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Technology

AI learns video game far faster by reading the instruction book

Matthew Sparkes

AN ARTIFICIAL intelligence has mastered the Atari computer game *Skiing* 6000 times more quickly than an AI competitor – just by reading the instruction manual first.

Atari computer games from the 1980s have become a benchmark problem for AI because they have simple controls, but completing levels is fairly complex.

5

Days of play for a new AI system to master the video game *Skiing*

The core approach for an AI to master these games is to give it a target, such as maximising a score or completing a level. To train the AI to do this, you give it snapshots – or frames – of the screen from games and it has to push a virtual button to make a move in response. Slowly, it builds up a statistical model of what order moves should be made in.

DeepMind's Agent 57 AI took about 80 billion frames to learn *Skiing*, in which you can steer left or right. The goal is to avoid trees and steer between pairs of poles as you descend. Now, Yue Wu at Carnegie Mellon University in Pennsylvania and his colleagues have enabled a game-playing AI to read the instruction manual by using another AI – a language model – to help it recognise what objects in the game the words "tree" and "pole" referred to (arxiv.org/abs/2302.04449).

This resulted in the gaming AI requiring about 6000 times fewer training iterations to master *Skiing* than Agent 57, needing some 13 million frames. Because the game runs at 30 frames per second, this is equivalent to the AI playing for five days, while Agent 57 needed the equivalent of 85 years of play, says Wu. "The things that DeepMind is doing are also very clever, but we have to attempt more efficient ways," he says. ■

Interview Brett Kagan

"I'm making brain cells play games"

Brett Kagan hopes brains in a dish will help us understand how human memories form and lead to a new kind of artificial intelligence, finds **Clare Wilson**

THE study of tiny spheres of human brain cells grown in a dish, known as organoids, is currently one of the hottest fields in neuroscience, with the potential to shed light on human brain development and neurological conditions. Now, computer scientists are hooking them up to electrodes in the hope of creating a new kind of artificial intelligence, based on biology.

Brett Kagan at Cortical Labs in Melbourne says his firm's first goal in the emerging field of "organoid intelligence" is to get the brain cells to master simple video games.

JESSICA KOUROUNIS/THE WASHINGTON POST/GETTY

Organoids made from human brain cells grown in a dish

Which game are you testing out on your brain cells in a dish?
Simple games, such as when an object moves towards you and you have to jump over it at just the right time. Like the jumping dinosaur you see if you're using [Google] Chrome and it crashes. We are also trying out *Pong* – a simple form of tennis. But with *Pong*, you need to have the paddle go in two directions. It's harder to try and give the brain cells two "buttons".

How do you know when the mini-brain "wants" to jump?
Neurons work by having small electrical signals, called an action potential. You can read these action potentials using electrical sensors. We can designate an area as a "jump" area and if activity increases there, we treat it as a jump.

And how do you signal that an object is coming nearer?
To put information in, you do the reverse: you apply small electrical signals in a given place at a given time. As the object gets closer, you can stimulate in different areas, or stimulate it quicker, or in more areas at the same time.

JEREMY DIXON

Profile
Brett Kagan is chief scientific officer at Cortical Labs in Melbourne where he works on developing the field of "organoid intelligence"

Can you see the brain cells playing the game? Do you have a visual representation of the jumping?
Of course – because it's fun for us and it's helpful for analysing the behaviour. But it's really for our benefit, not the organoids'. These systems aren't animals or humans in a dish. They are a different sort of information-processing system that probably has more in common with a computer than anything else, because it's not connected up [to a body] in the way that an animal or a human is.

Why study brain cells in a dish rather than a live organism?
There are so many things going on in the brain of even a simple animal, it's difficult to figure out the mechanisms. But with these cells in a dish, you can pull it apart to understand why one learns and another doesn't. We're studying not just memory formation, but also intelligence – we have very little idea how intelligence arises.

Could organoid intelligence really be better than computers?
The hope is that we get a lot closer to biological-like intelligence that is adaptable, requires relatively little data and is able to learn quickly. The important thing is to consider the right tool for the job. If I want to know the square root of 27,405, my phone will do it just fine. On the other hand, if I go into a stranger's house and want to make a cup of tea, our best machine-learning algorithms would take thousands and thousands of trials to achieve it. That's a lot of broken crockery.

What kind of practical tasks could organoid intelligence help us with?
Machine learning-based things very often struggle with changing environments in tasks like navigation robotics, and yet even simple worms can navigate new environments. Tasks could include things like self-driving cars – a seeing-eye dog is still one of the best aids you can give to someone who's visually impaired. Other things are optimisation problems, trying to figure out how to get from point A to point B, via multiple other steps.

Aren't those kinds of problems too complex for organoids?
We are in the very early stages of this. We are trying to mimic how human brains learn in a synthetic way. The focus is in how you build their environment, and so we call this environmental programming. In the history of computing, first, there was explicit imperative programming, using classic programs like Python, C and so on. Then came machine learning with statistical programming, where things are based on a probability for one event or another. We think organoid intelligence will involve a third type of programming, where we give the right environment to these little collections of cells, to get something useful to happen. We're really seeing the birth of a new field of science. ▮

Technology

Server heat may cut hot water bills

Waste heat from computer servers is being repurposed to heat hot water in homes

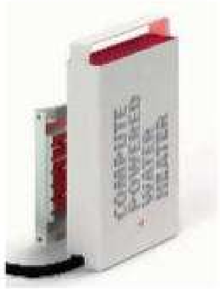
Matthew Sparkes

PEOPLE in the UK may soon be able to save about £150 a year on their energy bills by using a data server to heat their water.

About 45 per cent of energy consumed in data centres is used by cooling systems to stop servers overheating, even though there might be better uses for that excess heat.

Now, Heata, a start-up spun out of British Gas five years ago, has a solution that involves installing small data servers in people's homes. The company's shoebox-sized machines do away with cooling hardware and instead attach to a hot water tank.

The server uses the water tank as a heat sink to take waste heat away from its two processors, warming the water so it could be used for showers or the washing-up.



HEATA

A Heata unit that attaches to a hot water tank, so waste heat can warm water for your shower

The company has already run a trial with 20 homes and is now halfway through installing the devices for a larger trial – funded by the UK government – with 80 households, which will run for a year.

Chris Jordan, co-founder of Heata, says the devices will provide up to 4.8 kilowatt-hours of energy per day, which is about 80 per cent of the hot water demand of the average UK household.

The electricity use of the server is recorded by Heata and the cost of running it is reimbursed to the home owner. The company says that each home will save around £150 on its energy bills annually.

Jordan says Heata already has customers lined up to use the computer power available on the 80 servers, including architecture firms that need to do computer-intensive rendering of 3D animations.

The machines currently use a home's broadband connection, sending what Heata says will be relatively small amounts of data via a secure VPN. But the company says it is in talks with internet service providers to create connections solely for the use of the servers so they wouldn't eat into the data allowances of the households hosting the machines.

The units are fitted with alarms to notify the firm if anyone tries to gain access to the internal components. All data transmission is protected by 256-bit encryption to stop unauthorised people accessing it.

Peter Lewis, a plumber working in Hertfordshire, UK, says the idea is practical in principle, but that the results of trials will reveal how realistic the concept actually is.

£150

How much a water-heating server could save on energy bills

"Everything helps, and everything will save money in the long run," he says. "It's perfectly safe, there's nothing wrong with it. But as to how much heat [it generates] and the practicalities of installing it, it's a question of whether it's worthwhile or not." ▮

Climate

Deforestation seems to reduce rainfall across the tropics

DOMINICK SPRACKLEN

A downpour in the uplands of the South-East Asian rainforest

RAINFALL is decreasing in tropical areas where forests are being cut down, an analysis of satellite data has shown, confirming the predictions of climate models.

This decline in rainfall will lead to falling yields in the farmland now found in regions where forest has been cleared and could lead to a vicious cycle, says Callum Smith at the University of Leeds in the UK. "As agricultural yields decline, more forests will be chopped down."

Vast amounts of water evaporate from the leaves of trees in tropical forests, and this water may fall as rain nearby. When forests are cut down, less water is returned to the atmosphere above forests. Climate models suggest this will reduce rainfall, but studies of observed changes have had mixed results.

To get a better overall picture, Smith and his colleagues looked at satellite data showing how forest cover in the Amazon, the Congo basin and South-East Asia changed from 2003 to 2017. They compared this with satellite measurements of rainfall in these regions.

The researchers analysed the data at different scales. At the 40,000-square-kilometre scale, there was a 0.25-millimetre decline in rainfall per month for every percentage point of forest lost. This is within the high end of the range suggested by climate models (*Nature*, doi.org/jzrm).

If rainfall continues to decrease at the same rate as forests are felled, total deforestation would lead to a 10 or 20 per cent decline in rainfall in affected regions. But it is possible the trend will reach a tipping point, says Smith. "There could be a catastrophic fall-off in precipitation at a certain level," he says.

The study shows only correlation, not causation, says Yadvinder Malhi at the University of Oxford. It is possible that other factors, such as sea surface temperature changes, are playing a role too, he says. ▮

Michael Le Page

Infectious diseases

Norovirus cases surge in England

This winter has seen an unusually large number of norovirus infections and the outbreaks aren't over yet. **Jason Arunn Murugesu** investigates what is going on

THE numbers of norovirus cases in England are the highest they have been in over a decade and are still rising, according to the UK Health Security Agency (UKHSA).

In the current winter season, up until 19 February, which is the latest data available, there have been 4551 lab reports of norovirus in England. The number of reported cases for the two weeks up to 19 February is 14 per cent higher than for the previous two weeks, meaning this spike is coming quite late in winter, although the timing of the season varies from year to year.

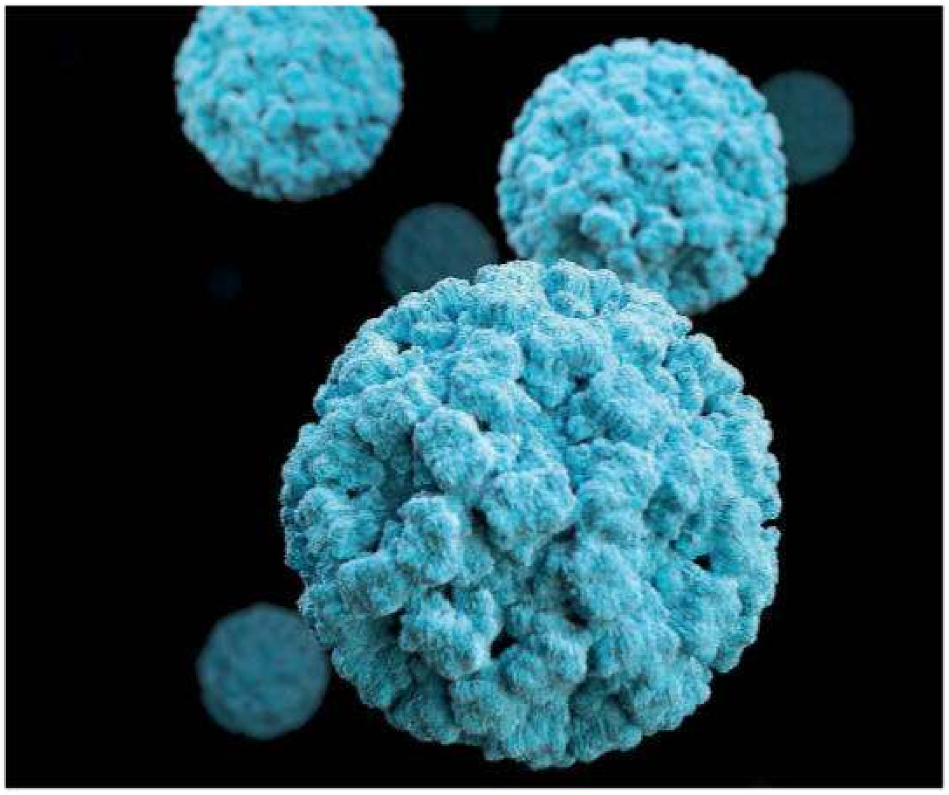
> "A very small amount of virus particles can cause illness, so it is easily transmitted"

There have also been 24 per cent more lab-confirmed cases of norovirus in England this winter than the five-season average before the emergence of covid-19. The majority of cases appear to be in people over 65 in care homes. What is behind the outbreak?

Norovirus, also known as the winter vomiting bug, is typically a mild condition that causes fever, vomiting and diarrhoea, lasting for two or three days. It affects nearly 5 per cent of the population every year in the UK.

The noroviruses that cause it are spread by an infected person not washing their hands adequately after using the toilet and then passing viruses directly to others or leaving them on surfaces they touch. The viruses can also be spread via touching or breathing in particles from an infected person's vomit.

"A very small amount of virus particles can cause illness, so it is easily transmitted," says Allison Aiello at Columbia University in New York.



CDC/SCIENCE PHOTO LIBRARY

Noroviruses cause gastroenteritis

4551

Number of norovirus cases reported in England this winter

24%

Rise in lab-confirmed coronavirus cases in England this winter compared with long-term average

65+

Age group seeing the majority of norovirus cases in England

Norovirus cases usually spike during winter, says Kathleen O'Reilly at the London School of Hygiene & Tropical Medicine. "This is because the virus survives much better in cold and damp conditions," she says. "Additionally, people are much more likely to meet indoors in winter, which also helps spread norovirus due to less ventilation than outdoor settings."

During the height of the coronavirus pandemic in England, the number of norovirus cases plummeted. Much of this may be because of lockdowns and social-distancing measures reducing transmission of other viruses as well as the coronavirus, says Aiello, but the UKHSA says it could also be due to fewer tests being done for norovirus cases as a result of reduced testing capacity and less access to healthcare.

Norovirus cases were expected to rise this winter in England as people mixed more freely, says O'Reilly, but why they have so quickly surpassed pre-pandemic levels isn't known.

Cases in Scotland are also higher than the five-year average before the coronavirus pandemic. Yet such a rise doesn't seem to have occurred in many other countries. Wales and Northern Ireland haven't reported the same trend, and in the US, for example, norovirus cases have largely returned to levels seen before the start of the pandemic.

Reduced immunity

O'Reilly says the high number of cases in England could be due to reduced immunity to the virus after several winters with fewer-than-usual norovirus cases, but it isn't clear why that wouldn't also apply to other countries.

The majority of norovirus cases appearing in over-65s isn't surprising, says Jerne Shapiro at the University of Florida. People of this age are more likely to live in nursing homes or long-term care facilities, she says.

"These facilities have a high level of contact between residents, visitors and healthcare workers," says Shapiro. "And then when you combine these environmental conditions with a virus that can easily be spread by contact as well as aerosolisation when someone vomits – it is easier to cause an outbreak."

The number of infections in younger age groups may be higher than is being reported, some researchers suggest, because most people won't go to a doctor if they have norovirus, so samples won't be collected, whereas sampling is more common in care homes.

"It's not yet clear to me whether the apparent increase reflects heightened disease activity or better surveillance and reporting of cases among older adults," says Benjamin Lopman at Emory University in Atlanta, Georgia. ▮

Health

Mediterranean diet may ease cognitive issues related to MS

Grace Wade

PEOPLE with multiple sclerosis who adhere to the Mediterranean diet are less likely to have cognition issues. This suggests that the diet – featuring fresh produce, seafood, nuts, olive oil and minimal red meat and sugar – may prevent cognitive symptoms related to the condition.

Multiple sclerosis (MS) is an autoimmune disorder that affects the brain and spinal cord. More than half of people with MS experience impairments to memory, attention span and processing speed.

Ilana Katz Sand at the Icahn School of Medicine at Mount Sinai in New York and her colleagues recruited 563 people with MS, all younger than 65. Each participant was scored on how closely they followed the Mediterranean diet on a scale from 0 to 14, with higher scores reflecting better adherence. They also underwent three cognitive assessments. Scoring below the fifth percentile on at least two of the assessments indicated cognitive impairment.

After adjusting for age, sex, race, socioeconomic status, sleep, exercise and other health-related factors, the researchers found that adherence to the Mediterranean diet was associated with a lower risk of cognitive impairment. Nearly 34 per cent of the 133 participants who scored between 0 and 4 on the Mediterranean diet questionnaire had cognitive impairment. But for the 103 people who had a score higher than 9, just 13 per cent had cognitive impairment. The findings will be presented at a meeting of the American Academy of Neurology in Boston in April.

The mechanism behind this isn't clear, but Katz Sand believes it could be related to the gut microbiome. "Diet has a big influence on the composition of bacteria that live in the gut and is also a big determinant of what those bacteria produce," she says. ▮

Biology

Stray dogs of Chernobyl are genetically distinct from others

Alice Klein

DOGS living in and around the Chernobyl Nuclear Power Plant in Ukraine are genetically distinct from dog populations living further away from the site of the nuclear accident, according to a genetic analysis. The results will be used to try to understand the long-term genetic effects of radiation exposure.

After the Chernobyl nuclear plant exploded in 1986, people living nearby were evacuated. The pets they had to leave behind were culled by authorities to try to stop them from spreading radioactive contamination.

Some pet dogs, however, managed to evade hunters and were fed and cared for by clean-up workers. More than 800 descendants of these dogs are now thought to be living inside and around the defunct nuclear plant.

To explore the effects of the large amounts of radiation released by the nuclear accident on this population, Elaine Ostrander and Gabriella Spatola at the US National Human Genome Research Institute in Bethesda, Maryland, and their colleagues collected blood samples from 302 dogs in the Chernobyl area and sequenced their genomes. The sampling took place between 2017 and 2019, before Russia's ongoing invasion of Ukraine.

"A disaster like this has only happened once in human history, so we want to learn from it"

Of the dogs sampled, 132 lived in close proximity to the nuclear plant, either inside the facilities that store spent nuclear fuel, in the railway station next to the plant or in the woods directly surrounding it. Another 154 were stray dogs in Chernobyl City, a largely abandoned town 15 kilometres from the nuclear plant. The last 16 were stray dogs in Slavutych, a more populated area 45 kilometres from the plant that has been exposed to less radiation.

Dogs at the site of the Chernobyl Nuclear Power Plant

CLEAN FUTURES FUND

The researchers compared these genomes with those of more than 200 dogs from other parts of Ukraine and 12 nearby countries. Like those sampled near Chernobyl, they were all mongrels, not pure-breed dogs.

The genomes of the dogs living close to the nuclear plant and in Chernobyl City were both markedly different to those of dogs in Slavutych, other parts of Ukraine and other countries (*Science Advances*, doi.org/grvvjp).

At this stage, it is unclear whether this is because their genomes have been altered by radiation, because individuals with certain genetic features have been more likely to survive the radiation and pass down their genes, or as a result of 37 years of inbreeding due to the dogs' relative isolation.

"We had to characterise these different populations as the necessary first step in order to do the experiment we want to do next, which is to find out how [the Chernobyl dogs] have survived in this hostile environment of radiation, cold temperatures and limited food," says Ostrander.

The results of further studies may help to identify genetic variants that increase cancer resistance. This could assist the development of protections against radiation exposure, both for people on Earth and those venturing into space, where radiation levels are higher, say the researchers.

"A nuclear disaster like this has only happened once in human history – we hope it never happens again – so we want to learn everything we possibly can from it," says Ostrander. ▮

Artificial intelligence

ChatGPT tells robots what to do

People with no programming experience could use AI to command robots for them

Matthew Sparkes

MICROSOFT says it has used the natural language AI ChatGPT to control a range of robots with simple text commands. The approach means people with no engineering or coding experience will be able to instruct sophisticated robots to carry out tasks.

ChatGPT was created by OpenAI, a company that is itself partly owned by Microsoft. The chatbot was trained on a vast amount of data, including source code. It has previously demonstrated the ability to write software based on text prompts and even to fix errors in existing code.

Microsoft has now used the AI to take text commands from humans and interpret them into code that can control robots directly. In one test, ChatGPT wrote code to instruct a robotic arm to create a Microsoft logo from wooden blocks. In another, it steered a drone to reach a point while avoiding obstacles.

Microsoft said in a blog post that the research was intended “to see if ChatGPT can think beyond text, and reason about the physical world to help with robotics tasks”.

Robots are typically controlled by software that has been written by humans and sets out precise instructions, or else by some form of relatively simple neural network AI that can learn to carry out tasks based on large numbers of examples.

Neither Microsoft nor OpenAI responded to a request for comment, but Microsoft said in its blog post that ChatGPT allows a user to give a robot instructions and then either review the code it outputs to check for errors or watch a simulated robot executing them. The user can then give feedback if needed.

Robot arms similar to these ones can be controlled by OpenAI’s ChatGPT

MATT CROSSICK/ALAMY

ChatGPT isn’t in direct, real-time control of the robot, but simply creates the code that controls it. Microsoft said in its blog post that ChatGPT output shouldn’t be deployed directly onto a robot without “careful analysis”, but experts warn that it is risky to even begin thinking about placing AI in control of physical machines.

Mark Coeckelbergh at the University of Vienna, Austria, says that regulations may be needed in order to set out where AI can be used and who is responsible should things go wrong.

“It’s a very dangerous thing to just say ‘let’s give control of these computers to AI’,” says Coeckelbergh. “The problem with contemporary artificial intelligence is that it’s not transparent to the user. That’s a huge problem.”

Others were sceptical about the ability of language models to program robots for complex tasks. Kathleen Richardson at De Montfort University Leicester, UK, says that AI language models are convincing mimics, but that their real ability – including their adaptability to control robots – is often overblown.

“I think Microsoft, and most people who design robots, over-inflate what they can and can’t do,” she says. ▮

Evolution

Influenza viruses may have originated in ancient fish

A FLU virus found in a sturgeon hints that influenza viruses began in fish around 600 million years ago and evolved with their hosts to infect a wide range of species today.

Influenza viruses cause illness in many vertebrates, including humans, birds, cats, whales and dolphins, but little is known about how they first evolved.

In 2018, researchers identified an influenza virus from a hagfish. By making a genetic family tree, they found that the hagfish virus resembled the ancestral form of influenza, suggesting that these viruses may have arisen in fish.

Influenza viruses have since been found in other fish, but it still isn’t clear whether they replicate in living fish, how they are transmitted and how the infection affects the fish.

Now, Mary Petrone at the University of Sydney and her colleagues have found more evidence that influenza viruses first evolved in fish. To do this, they searched genetic data from fish for sequences similar to the previously identified hagfish-associated flu virus. In particular, they looked for a gene encoding a crucial protein for replicating the virus’s genome.

This revealed an influenza virus that was 25 per cent genetically similar to the hagfish-associated virus, discovered in the intestine of a sturgeon from a fish farm in China (bioRxiv, doi.org/jzf9).

By comparing the genetic sequences of all known influenza viruses, the team found that the sturgeon virus looks highly similar to what the ancestral form is thought to have looked like, says Petrone.

“Understanding the evolution of the flu virus could help with detecting the next pandemic”

“Understanding the evolution of the flu virus is really important because it could give new insights into its ability to jump between hosts, and help with detecting the next virus with pandemic potential,” she says.

“The study provides compelling evidence that influenza viruses have an aquatic origin,” says Robert Gifford at the University of Glasgow, UK. ▮

Carissa Wong

Astronomy

Satellite streaks threaten Hubble telescope images

Alex Wilkins

TRAILS of light from satellites appeared on twice as many photos taken by the Hubble Space Telescope in 2021 compared with 2002. Although the unwanted light streaks haven't yet interfered with Hubble's scientific operations, they may do so in future – particularly as the number of communications satellites launched is rising.

Hubble orbits Earth at an altitude of about 535 kilometres, which is below many orbiting satellites. When taking long-exposure shots, where its light-sensitive aperture is open for several minutes to gather more light, satellites that pass in front of it can leave a white streak on the resulting image.

"It's only a matter of time before the scientific productivity of Hubble declines"

Sandor Kruk at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, and his colleagues noticed these streaks while analysing Hubble images for a citizen science project looking for asteroids.

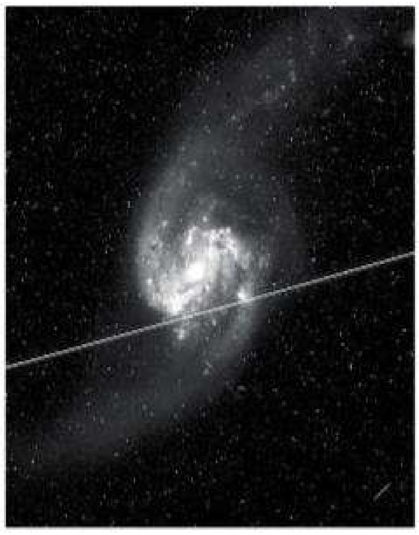
They decided to analyse all images taken by Hubble that had an exposure time of approximately 11 minutes that had been taken between 2002 and 2021 – a total of more than 100,000 exposures – using a machine learning algorithm to detect when a satellite had crossed an image. "The fraction of images that were crossed by satellites has increased over the last 20 years, from about 2.5 per cent in 2002 to 5 per cent in 2021," says Kruk.

Given the large number of additional satellites put into orbit since 2021, the proportion of images affected is likely to be even higher now, he says (*Nature Astronomy* doi.org/jzhk).

While a significant number of images have been affected by satellite trails, we have yet to see an impact on Hubble's scientific operations. Future satellite streaks could be mitigated using post-processing techniques, such as taking multiple images and then using comparison algorithms to filter out the satellite streaks, says Kruk.

However, this wouldn't work for rare events that happen only once and very briefly, says John Barentine at Dark Sky Consulting, a company based in Tucson, Arizona. If space companies launch as many satellites as they have publicly announced plans for, then the contamination rate of Hubble photos will increase by a factor of 10 over the next decade, he says.

"It's only a matter of time before the scientific productivity of the Hubble Space Telescope begins to decline somewhat as a result of data lost to satellite trails," says Barentine. ▮

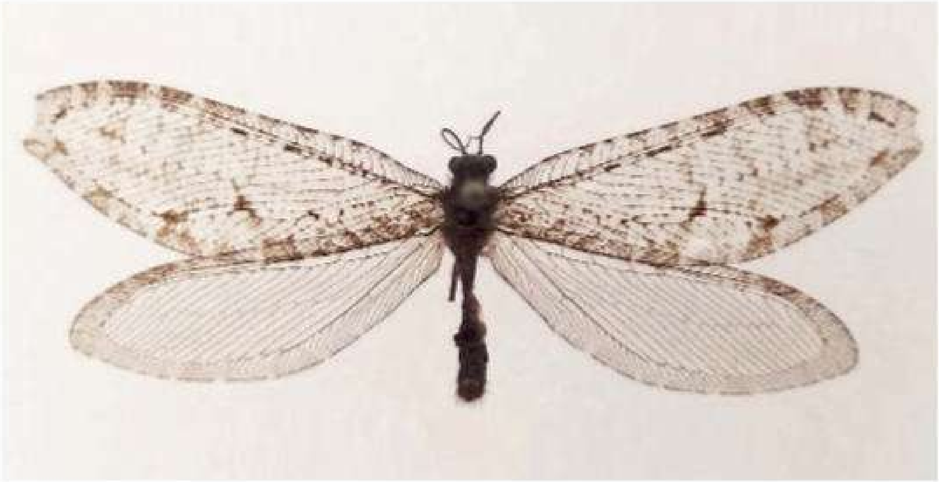

NASA, ESA, KRUK ET AL.

Satellite trails crossing an image of galaxy ARP248, captured by Hubble

Life

Insect thought extinct found in a Walmart

Corryn Wetzel


MICHAEL SKVARLA/PENN STATE

Giant lacewings were thought to be extinct across eastern North America

FOR the first time in more than 50 years, a giant lacewing (*Polystoechotes punctata*) has been found in eastern North America. The discovery raises new questions about the distribution of the Jurassic-era insect that mysteriously vanished from the eastern seaboard decades ago.

The giant lacewing was once abundant across North America, but the insect's eastern population began to plummet in the 1800s for unknown reasons – potentially due to the rise of urban development, invasive species and artificial light.

Giant lacewings had never been documented in Arkansas before, so when entomologist Michael Skvarla at Pennsylvania State University spotted an unusual insect with a roughly 50-millimetre wingspan on the facade of his local Walmart in 2012, he assumed it was from a more common group of insects called antlions.

"I picked it up and just walked around the store with it between my fingers as I did my grocery shopping and checking out, and then held it the entire way home," says Skvarla. He then killed and pinned it, hoping to take a closer look, but the insect sat in storage for nearly a decade before he examined it again. He didn't make the revelation until 2020 while teaching a university course on insect identification over video, examining specimens from his collection under a microscope attached to his computer. "It was immediately apparent that it wasn't an antlion," says Skvarla, who noticed an unusually large number of veins in its wings.

Later in the lab, Skvarla tried to extract DNA from the lacewing's leg that could have helped pinpoint its origin population – whether it was just an interloper from out west or if it was from an eastern population – but was unable to.

Skvarla suspects his Walmart lacewing was a member of a relic population that has managed to hold on, potentially in the nearby Ozark mountains. Finding this giant lacewing "suggests there are likely other small populations of the insect holding on in wooded areas in the east", says Robert Dowell at the California Department of Food and Agriculture.

Locating the insect in a suburban area also demonstrates the adaptability of the species, which has lived through the extinction of dinosaurs and the industrial revolution, says Jessica Ware at the American Museum of Natural History in New York. ▮

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Julie Seibt
Senior Lecturer in Sleep and Plasticity, Surrey Sleep Research Centre

Anil Seth
Professor of Cognitive & Computational Neuroscience (Informatics), School of Engineering and Informatics, University of Sussex

Manos Tsarikis
Professor of Psychology, Royal Holloway, University of London

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Space

What we learned from NASA's asteroid-smashing DART mission

Leah Crane

NASA crashed a spacecraft into an asteroid in 2022 in an attempt to move it, and the collision had more effect on the asteroid's orbit than predicted. An analysis of the aftermath has revealed why, and the results could teach us more about how to protect our planet.

The Double Asteroid Redirection Test (DART) sent a probe careening into a small asteroid called Dimorphos, which orbits a larger one called Didymos. Five groups of researchers have now analysed different aspects of the collision, which pushed Dimorphos closer to Didymos, making every orbit about 33 minutes shorter than before the smash – more than 25 times the change in orbital period required for the mission to be a success (*Nature*, doi.org/jzgg, doi.org/jzgn).

That was helped by DART being right on target. "The spacecraft hit very close to the centre… of Dimorphos, which is where you want to hit in order to maximise the momentum transfer," says Carolyn Ernst at Johns Hopkins University in Maryland.

NASA/JOHNS HOPKINS APL

Dimorphos as seen by the DART spacecraft seconds before impact

But perhaps more importantly, parts of the asteroid flew off after the collision, giving it an extra push. "People may think of the DART mission as a fairly straightforward experiment that is similar to playing billiards in space – one solid spacecraft impacts into one solid asteroid," says Cristina Thomas at Northern Arizona University.

But most asteroids – including Dimorphos, as it turns out – are rubble piles tenuously held together by gravity. When DART hit it, between 0.3 and 0.5 per cent of the asteroid's mass came flying off in a huge plume of ejecta. This plume amplified the momentum transferred from the spacecraft to the asteroid by a factor of 3.6 (*Nature*, doi.org/grvjkh, doi.org/grvptp).

Understanding that extra push will be crucial to any future DART-like missions. "Ejecta is going to give a larger push to the asteroid than the spacecraft itself, so that means in the future if we have to use this technology to divert an asteroid from hitting Earth, then we don't necessarily need a huge spacecraft," says Jian-Yang Li at the Planetary Science Institute in Arizona.

The plume of ejecta also puts Dimorphos in a strange category of asteroids called active asteroids, which have tails like comets. It has long been thought that these tails might form from collisions with smaller space rocks, and DART has shown that idea to be a good fit (*Nature*, doi.org/grvjkd). "We can now really nail down what's going on with active asteroids, and that helps us figure out what they're made of, which ties back to the birth of the solar system when they formed," says Ariel Graykowski at the SETI Institute in California.

"The best way to apply what we've learned is to do it again on something bigger"

After DART, we know that we can change the trajectory of a small asteroid like Dimorphos, but all asteroids are different, so we can't be sure that a similar mission would work on anything that might be headed our way. "I think the best way to apply what we've learned is to do it again on something bigger," says Graykowski. ▮

Biology

Insects shoot drops of urine using an anal catapult

TINY sharpshooter insects produce so much urine that they catapult it out of their bodies in energy-efficient, high-speed droplets instead of streaming it out.

Sharpshooters, which are a kind of leafhopper and are only a few millimetres in length, feed on the sap in plants' xylem tubes. This sap has a very low concentration of nutrients, meaning that the insects have to consume a lot and eliminate up to 300 times their body weight in liquid waste each day.

Saad Bhamla at the Georgia Institute of Technology in Atlanta and his colleagues wondered how the tiny insects could afford to spend the additional energy needed to urinate as much as they do.

"If you were only drinking diet lemonade, and that was your entire diet, then you really wouldn't want to waste energy in any part of your biological process," he says. "That's sort of how it is for this tiny organism."

To understand the insect's secret, the researchers analysed 22 waste ejections from five glassy-winged sharpshooters (*Homalodisca vitripennis*). In particular, they observed the movement of a pointy, hairy appendage called the anal stylus as it rotated and opened to squeeze out a droplet. Each droplet grew for about 80 milliseconds, then the stylus rotated slightly more to create a spring-load.

BHAMLA LAB, GEORGIA TECH

A glassy-winged sharpshooter with a droplet of urine on its anal stylus

At that point, the stylus made a fast twist, catapulting the droplet into the air. Remarkably, the droplets moved 40 per cent faster than the squeezing stylus did when it propelled them – a phenomenon known as superpropulsion (*Nature Communications*, doi.org/jzf8).

Larger animals and humans don't need to have such an energy-efficient urination system because – when compared with their energy intake, muscular strength and urinary output – the cost of producing streams is negligible. "But making jets when you're as small [as a sharpshooter] is very hard," says Bhamla. ▮

Christa Lesté-Lasserre

Environment

Adding wild fungi to soil could make trees store more carbon

James Dinneen

A START-UP has begun planting fungi collected from healthy forests at a tree plantation in the US state of Georgia. The effort to "rewild" the soil microbiome may help grow trees that store more carbon.

Fungi and other microbes in soil are important factors for tree growth and health. Many species of mycorrhizal fungi, for instance, have evolved to form symbiotic partnerships with certain trees, helping roots access nutrients in exchange for carbohydrates produced by the trees.

"They're completely dependent on the photosynthetic products coming from the tree," says Colin Averill, an ecologist at ETH Zürich in Switzerland and founder of Funga, the company behind the Georgia project. Disruptions from agriculture, such as clear-cutting, can kill these symbiotic fungi and alter the soil's microbial diversity.

With Funga, Averill is using soil from intact forests to inoculate newly planted trees to make them grow bigger and faster, generating carbon credits the company can sell. The concept is similar to faecal transplants for gut microbiome disorders, says Averill. "But we apply it to the forest."

In mid-February, work started on inoculating soil on 40 hectares of a commercial loblolly pine plantation near Lexington, Georgia. The planting is straightforward: a scoop of soil from an area of intact forest is added to a hole where a sapling is planted. Identifying precisely which soil to scoop is more complicated.

"If you just plunk a tree in and inoculate it with some random fungus, it might work or it might not," says Cindy Prescott at the University of British Columbia in Canada, who wasn't involved in the project.

Over the past year, Funga researchers analysed tree growth rates and sequenced the DNA of soil microbes in 500 loblolly pine forests around the south-eastern US to identify which composition of microbes is associated with the most growth. They then collected these candidate microbes from the test site in Lexington and inoculated new saplings.

70%

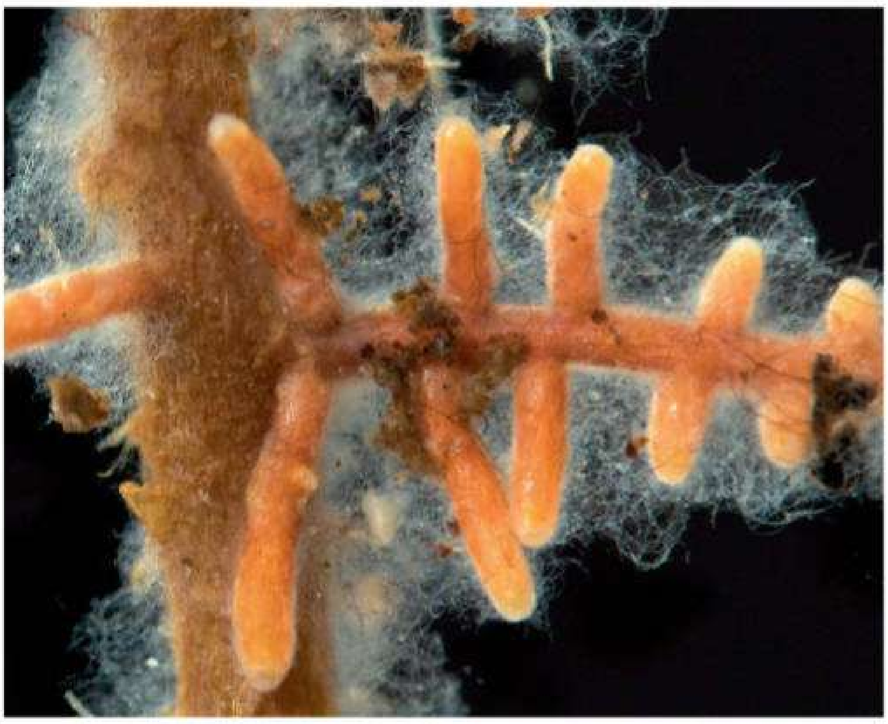
Possible biomass increase for trees planted with microbes

Averill says they also planted trees without the added soil to establish a baseline against which to compare any additional carbon stored by the inoculated trees. Results won't be available until the end of 2023, but Averill says similar methods increased forest productivity between 30 and 70 per cent at a research plot where he works in Wales.

He and his colleagues also analysed 81 experiments that examined how inoculating soil with wild microbiomes affected various types of plants in different ecosystems. They found a range of effects, from a small reduction of biomass to a more than 700 per cent increase. On average, plant biomass increased 64 per cent.

"It's going to do something," says Jennifer Bhatnagar at Boston University, though she says how much depends on a lot of factors, such as how degraded the soil is to begin with. She says the effects of soil restoration are better understood with saplings than with older trees. "When they get older, will that initial inoculant be enough?"

Sourcing the soil poses another challenge, says Prescott. Many species of fungi can't be cultured, and at larger scales, soil extraction could degrade the collection sites. ▮



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Roots of a spruce tree with mycorrhizal fungi

Technology

Self-driving car could be ordered to repossess itself

Matthew Sparkes

FORD has been granted a patent for a system that allows a car to repossess itself if its owner fails to keep up with payments. The firm envisions the car driving itself back to the showroom – or to a scrapyard if the value of the car is low.

The patent, which was filed in 2021 but only now granted, describes how the system would kick in if the car owner failed to respond to notifications that they were behind on payments. At that point, a series of measures would make the car unpleasant to drive, then impossible.

The system could begin by disabling features such as GPS navigation, the music system or the air conditioning, in order to create what the patent describes as a "certain level of discomfort" for the owner. If this doesn't work, the patent suggests enabling the car to create an "incessant and unpleasant sound", such as a chime or beep.

The next escalation would be to limit access to the car on certain days or at certain times. If all else fails, the car could be instructed to, when empty, drive itself to a repossession storage area or scrapyard.

Such a system would require the car to be fully autonomous, which has been a persistent, but elusive goal for car-makers. Ford recently announced it was giving up on full self-driving technology, having spent $2.7 billion working on it.

Ford didn't respond to a request for comment on the patent, but Alan Woodward at the University of Surrey, UK, says that there would be security risks with such a system.

"It'll be a brave vehicle manufacturer that builds this into their vehicle as standard," he says. "I can imagine a car thief not just finding an unauthorised way into the system, but also socially engineering 'authorised' users to give them access." ▮

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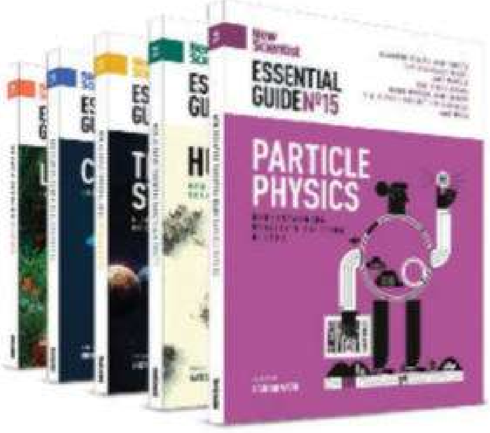

Exercise

Just 500 extra steps boosts heart health

WALKING 500 more steps a day may lower cardiovascular disease risk in older adults.

While it is known that regular exercise can reduce the risk of heart disease, it was less clear just how much – or how little – activity is needed to make a difference.

So, Erin Dooley at the University of Alabama and her team recruited 452 adults aged between 71 and 92 who wore a step counter for three to seven days. Levels of coronary heart disease, stroke and heart failure were tracked over the next three-and-a-half years.

After adjusting for factors such as age and sex, the team found that every extra 500 steps a day was associated with a 14 per cent lower risk of cardiovascular disease in this period. The results were presented at the EPI/Lifestyle conference in Boston. **Grace Wade**

Diet

Climate and health talk cuts meat eating

PRODUCING meat makes global warming worse and eating less of it is better for health. Just telling people this can lead to a sustained cut in meat consumption.

Andrew Jalil at Occidental College in Los Angeles and his team recruited 213 students at a US university with an average age of 19 and divided them into two groups. One listened to a talk on climate change, links between livestock and greenhouse gas emissions and deforestation, and how meat affects health. The other group had a talk unrelated to diet.

Before the talk on meat eating, 59 per cent of the meals chosen by the students were meat-based. This fell to 54 per cent on average over the three years after the talk. The students who had the unrelated talk saw no change in meat consumption (*Nature Food*, doi.org/jzhf). **Michael Le Page**

JOHN C. MITTERMEIER

Wildlife

Dusky tetraka found again after vanishing for decades

A RARE bird not seen for 24 years has been confirmed as alive in Madagascar's forests.

The sightings of the dusky tetraka, a small, ground-dwelling forest bird, may prompt a rewrite of ornithology textbooks, as the birds were seen by the rocky banks of mountain streams – not previously thought to be their favoured habitat.

The species (*Xanthomixis tenebrosa*), an olive bird with a yellow throat, was included in a top 10 "most wanted" list by the Search for Lost Birds, a conservation collaboration launched in 2021.

Since December, three individuals have been seen by two teams from The Peregrine Fund charity. Their expeditions were to forests on high mountain slopes, as this is where most remaining wooded areas are in Madagascar.

The first team found an individual near a stream in the island's Masoala peninsula by using a mist net, a fine mesh that is suspended between trees so birds get tangled in it. The net is checked frequently and then birds can be released unharmed. The second team's efforts didn't go smoothly at first, as it was discovered that much of the target region near Andapa had been turned into vanilla farms.

But when the team switched to lower ground, at about 800 metres above sea level, John Mittermeier at the American Bird Conservancy saw a pair of the birds in undergrowth by a stream. "It's a moment that's tremendously exciting, to be looking for something that long and then there it is," he says. "Afterwards, it felt like a dream."

The next day, the team netted what was probably one of the same pair and confirmed that it was the right species. **Clare Wilson**

Really brief

SPL

Predatory fish was no monster

***Dunkleosteus terrelli*, an armoured predatory fish with bladed jaws that lived 360 million years ago, wasn't 9 metres long and shark-like as thought. A study of the relationship between head and body length in fish now puts it at some 4 metres long and squat like a tuna (*Diversity*, doi.org/grvjq5).**

A way to play VR games on the bus

You could soon be playing virtual reality games on public transport without accidentally hitting fellow passengers. FingerMapper software translates the twitching of your fingers into much larger body movements in the virtual world, reducing the space needed for VR (arxiv.org/abs/2302.11865).

Possum tops list of mammals to save

The mountain pygmy possum of Australia, the aye-aye of Madagascar and Leadbeater's possum, also in Australia, are now the top three mammals we should try to save, according to a method for prioritising conservation based on how unusual a species is and how threatened it is (*PLoS Biology*, doi.org/jzhn).

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Helping people live longer, better

WHO ARE WE?

As the representative body for Directors of Public Health (DsPH), we work in partnership to strengthen the voice for public health across the UK. Every DPH within the British Isles and British Overseas Territories has the right to be a member, with Deputies and Consultants in Public Health and former DsPH able to apply for Associate or Alumni Membership.

We have a small staff team who support our members and advocate for their views.

WHAT WE DO

We work closely with a range of organisations from all sectors as well as local authorities, the NHS and Government departments to improve and protect the nation's health by:

- Representing the views of our members on public health policy
- Advising on policy and legislation on a local, regional and national level
- Providing professional development opportunities and a support network for members to share ideas and good practice

OUR IMPACT

As local leaders for the nation's health, DsPH commission services to improve and protect people's health and tackle health inequalities in their area. They bring together their technical expertise with decision makers, service providers and community and voluntary groups to identify what public health initiatives are needed and where so everyone can access support.

As their representative body, we play an important role in articulating the local public health perspective in national discussions. During the Covid-19 pandemic, when DsPH were instrumental in providing information and advice, the profiles of DsPH and ADPH rose significantly.

This increased understanding of the DPH role gives us an opportunity to advocate for, and make proposals on, a wide range of public health measures which could help everyone – regardless of where they live or how much they earn – live longer, healthier lives.

While our proposals are not always adopted, they regularly influence the approach taken by Government.

How to help

To broaden our reach and influence decisions that affect all our lives, we need to raise awareness of the DPH role even more. Follow us @ADPHUK and visit our website www.adph.org.uk to sign up for our newsletter and find out what our members – all experts in public health – do and think about a range of key issues, including:

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- How we can achieve Smokefree 2030
- The effect early childhood has on our future
- What the role of business is in health
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Culture
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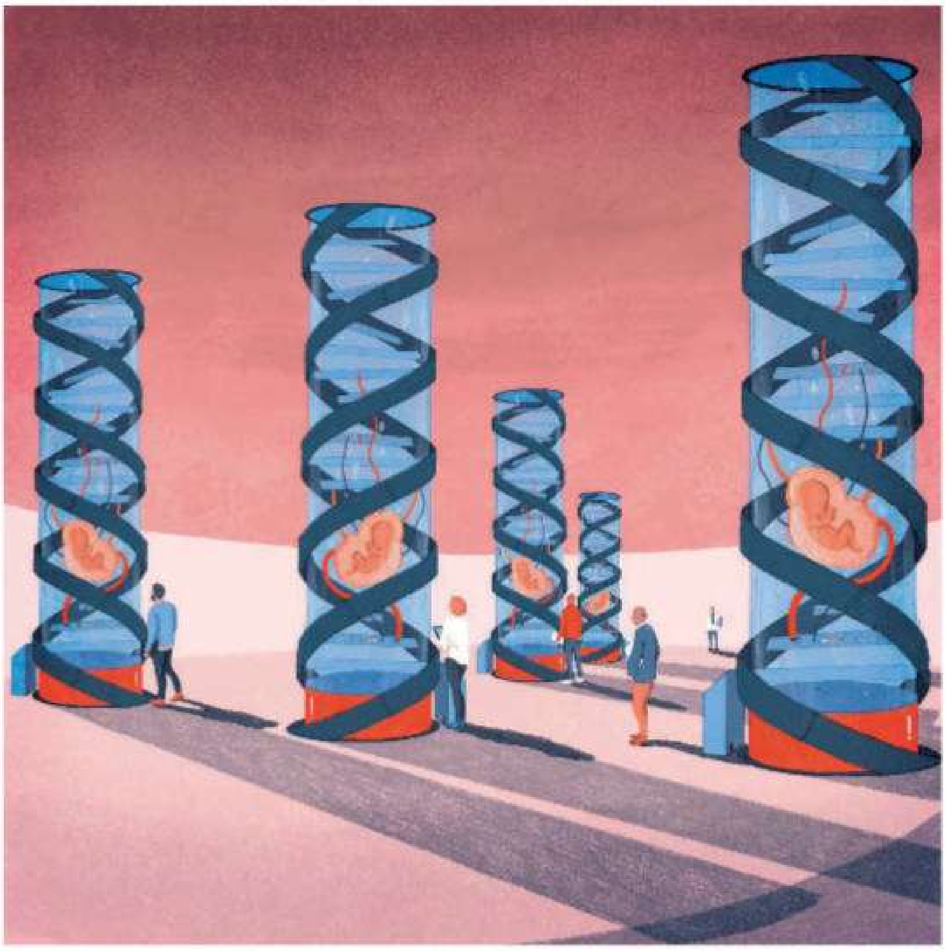
Comment

Whose child is it anyway?

A reform of surrogacy laws in England, Scotland and Wales could have major ramifications as reproductive tech advances, says **Teresa Baron**



SIMONE ROTELLA

MOST people assume that if you create a child, it is your child. But the links between creation, commission and child-rearing are growing more tenuous as reproductive technology advances and laws are reformed in response. In the coming decades, we might see the first children conceived using synthetic eggs and sperm and "born" through ectogenesis (artificial womb technology). How we respond to these advances will depend on what we do, between now and then, with the relationship between procreation and parenthood.

Since 2017, law reform bodies in England, Scotland and Wales have been refining proposals for a reform of surrogacy laws in these countries. Motivations include making surrogacy more accessible and less legally precarious, and clarifying ambiguities such as commercial payments for surrogacy. This is currently illegal in the UK, in theory: you can only pay a surrogate "reasonable expenses". But no parental application has yet been denied on this basis, leading some to argue the UK has de facto commercial surrogacy already. Legalising it would nudge laws in England, Scotland and Wales further from patterns seen across the EU and closer to models in Russia and some US states.

As a researcher in the philosophy of parenthood and reproductive ethics, my attention has focused on the proposal to lift, in some cases, the requirement for one or both commissioning parents to provide an egg/sperm. The practice of double donor surrogacy (DDS) would allow couples to commission surrogates to conceive a child using a donor egg (or their own) and donor sperm.

A handful of countries and states currently allow this: in Greece and California, a single woman or couple can commission a surrogate to conceive with eggs and sperm from anonymous donors. Legal parentage is determined on an entirely contractual basis. The result is a child with no biological link to the commissioning parents: is this still assisted reproduction or is it adoption-to-order?

Further suggested reforms might avoid this question by granting commissioning parents exclusive parental rights over the child from birth, paralleling legislation in countries like Greece; currently, surrogates in the UK must consent to terminate their default parental rights six weeks after the birth. Arguably, if there is no transfer of parenthood, it isn't technically adoption. Nonetheless, the commissioning parents aren't being assisted in reproducing. It therefore isn't clear that we can call this assisted reproduction, either.

Genetic parenthood is a deeply important ambition for many. This, together with broader ideas of reproductive freedom, is often taken as the basis for improving access to assisted reproduction. But these justifications can't stretch to cover DDS, in which neither the commissioning parents' reproductive autonomy nor their desire for biological offspring play a role. Adoption is often a lengthy and difficult process, and newborn infants are both most in-demand and least available – but does this justify commissioning "new" children for biologically unrelated prospective parents?

These proposed reforms have further ramifications for future technologies such as ectogenesis. If DDS becomes legal in England, Scotland and Wales, it will set a highly relevant precedent: a person may acquire a child via commission alone. This principle could carry over from DDS to the use of ectogenesis and artificial eggs/sperm.

If reproductive autonomy and parenthood come apart from (re)production, then the way in which we regulate these technologies might be simple – but whether that is a desirable world is quite a different question. ■

Teresa Baron is a University of Nottingham Research Fellow and author of *The Philosopher's Guide to Parenthood*

No planet B

Gathering storms Compound and cascading disasters, like back-to-back hurricanes, are becoming more common. Have we crossed the first climate tipping point, asks **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

A COUPLE of weeks ago I visited an experiment in a forest in the south of England that is attempting to make young trees old before their time. While I was there, I saw the aftermath of events of a year ago, when the UK was battered by three consecutive named Atlantic storms in just a few days. One of the casualties of that triple whammy was a large beech tree in the forest, felled by a branch that was ripped off its neighbour.

The arrival of three violent storms in less than a week is called a compound disaster – extreme events occurring either together or quickly one after the other, before recovery from the previous one (or ones) can play out. It was also a cascading disaster, where one extreme event triggers others. Storm Eunice, which made landfall in the UK on 18 February 2022 – a day after Storm Dudley – brought lengthy power cuts to more than a million homes, closed schools and businesses and disrupted the UK's transport system for days. When Storm Franklin arrived three days later, it hampered the clean-up operation from Eunice and led to significant flooding.

All over the world, compound and cascading disasters are becoming increasingly common as the climate warms. For the past two years, eastern Australia has been battling a succession of devastating floods that came hot on the heels of record drought, heat and wildfire conditions in 2019 and 2020. In New Zealand, the destruction wrought by Cyclone Gabrielle last month was compounded by further heavy rainfall a few days later. In 2021, parts of Louisiana in the US were hit by two hurricanes, Ida and Nicholas, in the space of just over two weeks. The list goes on.

Compound and cascading disasters aren't new, of course. In 1954, before climate change had truly kicked in, the north-eastern seaboard of the US was hit by two hurricanes, Carol and Edna, in the space of 12 days, killing 80 people and causing flooding and damage estimated at half a billion dollars. However, they are getting more frequent.

Such disasters "are the new normal", said Susan Cutter at the University of South Carolina in her keynote address to a recent US National Academies of Science (NAS) meeting on the topic. The report that followed described the "new normal" in stark terms, stating that "most disasters do not occur as isolated events and instead seem to pile on one another, disaster after disaster, often unleashing new devastation on a community before it has had a chance to recover".

> **"There is a school of thought that says compound and cascading disasters are precipitating a mental health crisis"**

Not all are climate-related. The recent examples all happened against the backdrop of another disaster, the covid-19 pandemic. Some involve natural hazards meeting vulnerable infrastructure, like the 2011 Tōhoku earthquake and tsunami in Japan, which flooded the Fukushima nuclear plant, sparking a meltdown there.

We can expect more. A recent paper reported that back-to-back hurricanes – hitting within 15 days in the same place – are getting more common on the east coast and Gulf coast of the US. What used to be a once-a-century event will happen once every two years or so by the end of this century.

Another future risk is a type of event called a "tropical cyclone-deadly heat compound hazard", where a cyclone or hurricane knocks out the power supply and is quickly followed by a heatwave. Air conditioning units don't work and millions are exposed to potentially fatal heat in excess of 40°C (104°F). Such events have previously been "vanishingly rare", according to Tom Matthews at King's College London. Only four were recorded between 1979 and 2017, all in sparsely populated north-west Australia. But climate models suggest they will become much more common, with as many as one every three years under 2°C of warming, putting millions of people at risk.

To me, this smacks of a tipping point, an irreversible shift in Earth's natural systems caused by climate breakdown. If so, it is arguably the first that we have crossed, though many others are close. It is a hugely impactful one, too. Disasters, by definition, affect people; compound and cascading ones have a larger impact than any one of their elements alone. There is even an emerging school of thought that says compound and cascading disasters are precipitating a mental health crisis as people experience these events with little or no time for recovery.

What, if anything, can we do? Short of holding warming to current levels – which isn't going to happen – not a lot. The NAS says there are two options: make disaster-response systems work harder and faster or redesign them completely to deal with such events, though it didn't say how this might be achieved. But we don't have much time to waste. According to the NAS, the new norm is an "untenable situation". The storm clouds have gathered.

Graham's week

What I'm reading

I'm still ploughing through grief lit. The latest on the pile is The State of Disbelief *by Juliet Rosenfeld.*

What I'm watching

The new season of ITV's cold case drama Unforgotten*.*

What I'm working on

Some grief lit of my own.

This column appears monthly. Up next week: Annalee Newitz

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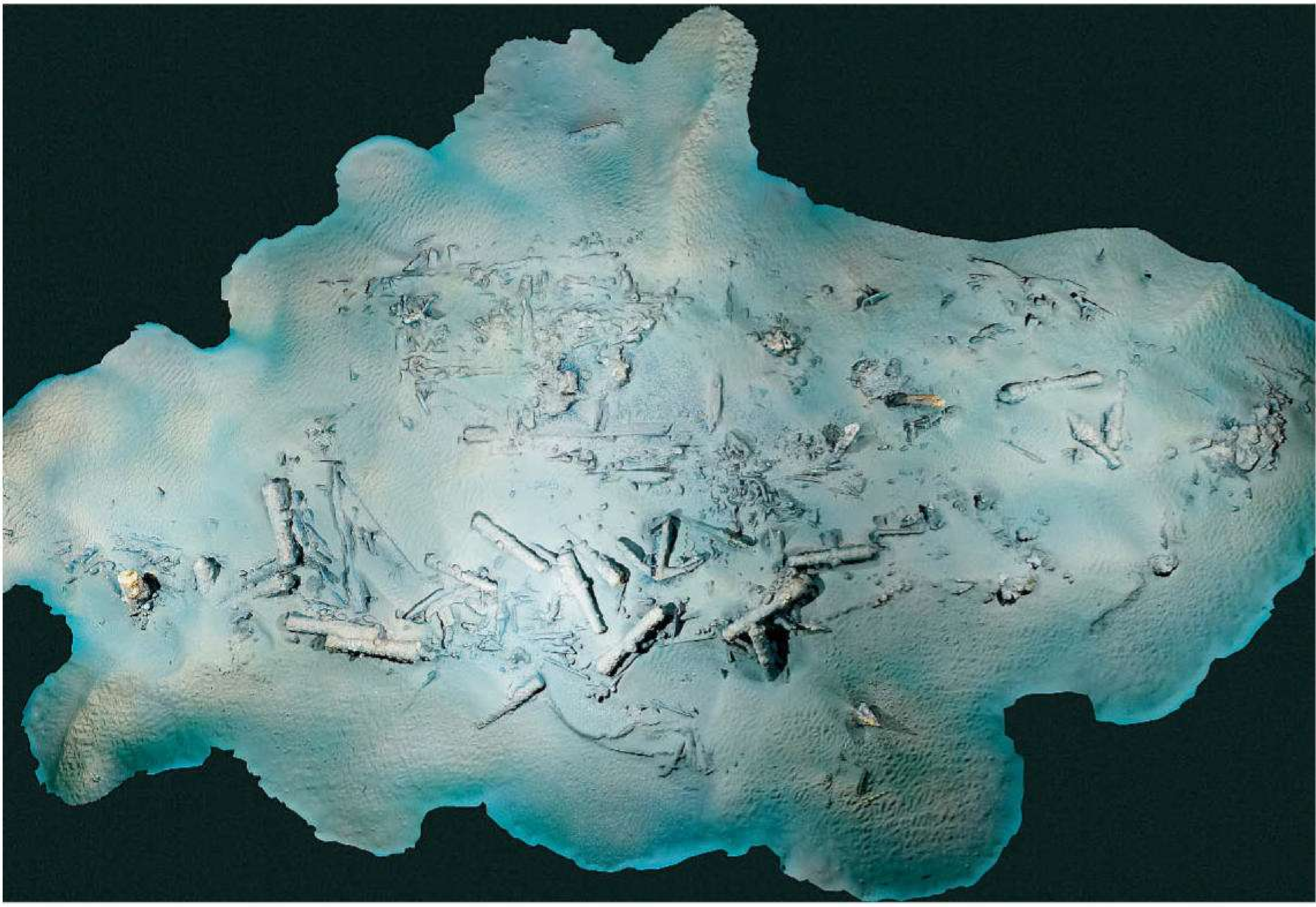

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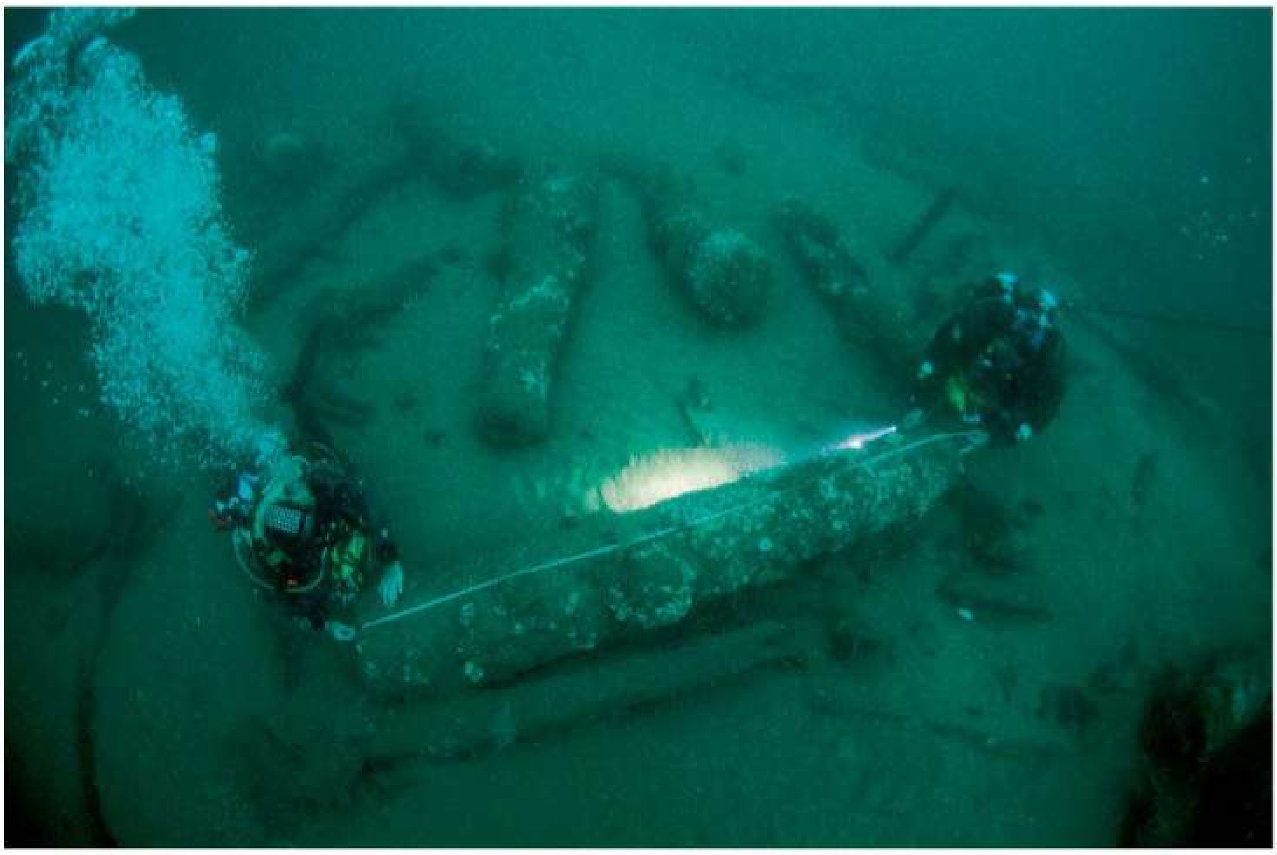

NORFOLK HISTORIC SHIPWRECKS

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Sunken treasure

Norwich Castle Museum and Art Gallery

THIS intriguing selection of images documents a catastrophic shipwreck that, after more than 300 years, has had some of its relics brought to the surface. They will be showcased in a new exhibition, The Last Voyage of the Gloucester, by the University of East Anglia and Norwich Castle Museum and Art Gallery, both in the UK.

In 1682, the warship HMS Gloucester set sail for Edinburgh carrying the future King James II of England and Ireland, who was also King James VII of Scotland. Not long into its journey, the ship struck a sandbank off the Norfolk coast and sank. James survived, but some 250 people on board died.

It wasn't until 2007 that the miraculously well-preserved shipwreck was discovered by brothers Julian and Lincoln Barnwell, who had spent years scuba diving in search of the vessel. However, the pair were unable to reveal their find until last year so it could be protected.

A 3D representation of the wreck site is shown at top left in a photogrammetry image from the Maritime Archaeology Trust. To its right, the square of smaller images shows (clockwise from the bottom left): a pair of glasses in their case; two salt-glazed jugs, known as Bellarmine bottles; and a "Sun in Splendour" bottle. All were found at the site. The last image in the square is a 1682 painting of the wreck by Johan Danckerts. The bottom row shows (left to right): the Barnwell brothers measuring the Gloucester's cannons; the ship's lifting tools on the seabed; and its 65-kilogram bronze bell.

The exhibition is at Norwich Castle Museum and Art Gallery until 10 September.

Gege Li

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Editor's pick

The shift to farming gets my vote as a force for good

25 February, p 28

From Frank Aquino, Perth, Western Australia

Was the shift to farming really the worst mistake in human history, asks Michael Marshall, concluding that the claim is at best an exaggeration. I would go further, drawing on relevant points made by the researcher Jacob Bronowski.

You can't civilise on the move. No group of humans has ever been able to allow its smarter individuals to sit around, think and build useful stuff – like universities, contact lenses and vaccines – without surplus food to give them thinking time. Hunter-gatherers are too busy every day feeding themselves.

I can't see an argument against the simple statement that growing crops was a good thing.

New climate technology would be a NET gain

18 February, p 27

From Stuart Lambert, London, UK

To argue that a focus on negative emission technologies (NETs) is slowing the fight against climate change is to fall into a common trap. A look at plans drawn up to meet the goals of the Paris Agreement will tell readers that NETs are a baked-in requirement for meeting the 1.5°C pathway.

Of the 400 scenarios with a 50 per cent or better chance of ensuring no more than 2°C of warming, 344 assume the large-scale deployment of a NET. We need these technologies.

AIs may look like they know our minds, but...

18 February, p 46

From Andrew Smyth, Los Angeles, California, US

On the subject of AIs with theory of mind, a machine will eventually be able to measure things – such as tone of voice, the look of a person's eyes, body position and so on – that we observe when "reading another person's thoughts". This machine will compare these measurements with a database and use an algorithm to select responses with which to interact with us. Yet such a computer will still have no conscious feeling or understanding.

The rapidly diminishing need for dark matter

11 February, p 46

From William Hughes-Games, Waipara, New Zealand

Surely, every time we find a new source of normal matter, this decreases the amount of dark matter we must hypothesise to explain the behaviour of galaxies.

One recent example is the discovery that there are far more red dwarfs than we thought. There are other candidates, too. How about cosmic rays: naked nuclei that travel at near light speed through galaxies? The density is low, but the volume is measured in thousands of cubic light years. There are many other possible answers out there.

From Troy Braswell, Rancho Palos Verdes, California, US

We know that one form of energy without matter is the photon. Could it follow that gravity without matter is the graviton? Could free gravitons, still exerting a pull, explain the gravitational effects of dark matter?

Black hole energy idea is ringing another bell

25 February, p 19

From John Davies, Lancaster, UK

The idea that vacuum energy at the cores of black holes may be the source of dark energy is awfully reminiscent of steady state theory. Instead of matter continuously being created everywhere in the universe in the latter, it is energy being spontaneously created only in black holes. Not so different.

Future Homes for all seems a long way off

25 February, p 11

From Rachel Mckeown, Cambridge, UK

One day, I hope to be able to have a "Future Home" of my own and reap the energy-saving benefits. However, houses are built to last, so the vast majority of homes won't be replaced soon. Green technology has to make its way into current homes, with better incentives to retrofit, replacing energy and carbon-intensive heating and electricity systems with cleaner improvements. My room, in a rented shared house, has single-glazed windows and not even my thickest jumpers and blankets keep me warm in winter.

Rivers campaign: Lack of investment landed us in it

Leader, 18 February

From Dyane Silvester, Arnside, Cumbria, UK

I passionately support your campaign, together with the *i* newspaper, to highlight the state of the UK's rivers.

Their current deplorable condition is surely down to the years, if not decades, of chronic underinvestment. For example, the UK government has left the Environment Agency without adequate resources to inspect and monitor water quality in England, or enforce regulations and impose hefty fines on polluters. And privatised water companies don't do enough to maintain, repair and upgrade their ageing and now inadequate infrastructure so that it isn't overwhelmed by storms.

Could veterinary advance explain tick results?

18 February, p 15

From Stephanie Woodcock, Carnon Downs, Cornwall, UK

It was always going to be a big ask to remove sufficient ticks from a semi-forested US area to truly affect Lyme disease rates for people. And yet, the rate of disease among pets did fall significantly. One possible explanation might be the fact that there is a vaccine for pets, but not people.

AI search engines may skew their own inputs

25 February, p 12

From Chris Eccles, Stockton-on-Tees, County Durham, UK

The article "Searching for answers" raises interesting questions about the use of AI language models such as ChatGPT in internet search engines. With AI also used to generate increasing volumes of internet content, will these systems end up training themselves with their own output? If so, what effect will this have on the accuracy of information on the internet?

Drastic energy saving is entirely possible

11 February, p 36

From Talia Morris, Cape Tribulation Tropical Research Station, Queensland, Australia

Your 2000-watt challenge article seems overly pessimistic about the difficulty of cutting energy use. We run our research station, with 12 buildings, on around 14 kilowatt-hours a day, generated by a solar power system with a battery backup. We have lighting, fans, dehumidifiers, power tools, a plethora of lab equipment and a good, basic washing machine. In no way do I feel that we are living in a state of deprivation.

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Up in the air

Claims about birds' migratory feats were often dismissed, until technology revealed the truth about their incredible journeys, finds **Corryn Wetzel**

Book

Flight Paths

Rebecca Heisman

HarperCollins

Technology has revealed the truth about the migration of birds like snow geese (above) and the blackpoll warbler (below)

STEVE BYLAND/ISTOCKPHOTO/GETTY IMAGES, LEE RENTZ/ALAMY

QUESTIONS about how and why so many birds make extraordinarily arduous annual migrations – and where they are going – have puzzled us for years. Perhaps they are flying to the moon, speculated 17th-century English educator Charles Morton; others had wondered if, when birds vanished, they might be hunkering down for the winter at the bottom of ponds.

More than three centuries later, scientists are still working to fully unravel the secrets of bird migration. In some cases, what they have uncovered is more surprising than even the boldest ornithologist could have predicted.

> "How could a bird weighing just 12 grams fly so far over the Atlantic Ocean in one go?"

Assessing the progress – and its implications – is the task of science writer Rebecca Heisman's first book. *Flight Paths: How a passionate and quirky group of pioneering scientists solved the mystery of bird migration* provides a peek into the drama behind some of the biggest discoveries in migration research.

Heisman punctuates her comprehensive history with a cast of inventive and sometimes obsessive minds, including Bill Cochran, a former electrical engineer from Illinois and part-time ornithologist, who developed a miniature radio transmitter light enough to attach to songbirds in the 1960s.

His decades-long quest to track birds led him into many misadventures, including being misidentified as a drug smuggler. Cochran is a gift for Heisman, who must have had to work hard elsewhere to add colour to what could easily be a technical tale. Her curiosity and descriptions are a boon for all unfamiliar with the birding world. I especially loved her vivid account of trying to find a ground-dwelling bird called a sora.

In its nine chapters, *Flight Paths* soars through the history of migration research, from counting passing birds against the glow of the moon in the 1950s to the recent advent of wearable trackers the size of jelly bean sweets.

Most people are now familiar with the idea that some birds travel thousands of kilometres seasonally for climate, food or mates, but the scientists first proposing the phenomenon were often laughed out of the room. Advances in technology are finally allowing research to confirm or debunk those early claims.

In the 1960s, ornithologist Ian Nisbet proposed that blackpoll warblers (pictured below left) were undertaking a far more impressive autumn journey than anyone had logged. As Heisman reports, Nisbet believed they were making the staggeringly long flight from eastern Canada to South American countries such as Colombia and Brazil.

Some of Nisbet's peers thought it absurd: how could a bird weighing just 12 grams (the same as an AAA battery) fly so far over the Atlantic Ocean in one go? After all, that would take days of ceaseless flying.

Five decades later, researchers were able to confirm Nisbet's notion with a device containing a light sensor and a clock to map the migration. This uses sunlight to work out a bird's latitude and longitude at a given time.

Understanding how, why and where birds migrate is about more than solving a mystery. It is critical for future conservation efforts. Migratory species are especially at risk because they rely on a network of healthy, connected habitats, and the window of opportunity to act is slamming shut. In 2019, a study by the US's National Audubon Society found that North America alone had lost around a quarter of its birdlife since 1970, which amounts to around 3 billion individual birds. "If we don't know where birds are going, we don't have the information we need to save them," says Heisman.

Flight Paths is a vital wake-up call to birders, ornithological societies and governments. ▮

Who created science?

Physicist Carlo Rovelli argues that science owes its origins to ancient philosopher Anaximander. **Simon Ings** investigates

Book

Anaximander and the Nature of Science

Carlo Rovelli
(translated by Marion Lignana Rosenberg)
Allen Lane

ASTRONOMY was conducted at Chinese government institutions for more than 20 centuries before Jesuit missionaries turned up and, somewhat bemused, pointed out that Earth is round. Why, after so much close observation and meticulous record-keeping, did 17th-century Chinese astronomers still think Earth was flat?

Theoretical physicist Carlo Rovelli addresses this in *Anaximander and the Nature of Science*, his first book, released in French in 2009 and now published in the UK for the first time in this lively English translation. He can be certain of one thing: "the observation of celestial phenomena over many centuries, with the full support of political authorities, is not sufficient to lead to clear advances in understanding the structure of the world".

So, how had Europeans managed to come to this insight? Rovelli ties his answers to the life and work of Anaximander, born in 610 BC in the cosmopolitan ancient Greek city of Miletus, the ruins of which are on the coast of modern Turkey.

We know about that work mostly through Aristotle because Anaximander's only known treatise is lost, aside from a tantalising fragment revealing his notion that there are natural laws that organise phenomena through time. He also worked out the causes of wind and rain, and deduced that all animal life came from the sea, arising from fish or fish-like creatures.

Rovelli isn't interested in such examples of apparent prescience. He is enchanted, though, by the quality of Anaximander's thought. Take the philosopher's most famous observation – that Earth is a finite body of rock floating freely in space. Anaximander suggests there is a void beneath Earth through which heavenly bodies like the sun must travel when they roll out of sight.

This isn't saying much more than: when someone walks behind a house, they will reappear on the other side. Yet what makes this observation so radical is that, when applied to heavenly bodies, it contradicts everyday experience, where objects fall in one direction. The fact that the sun rises again suggests that space doesn't have a privileged direction in which objects fall – an idea that runs against "common sense".

So, Anaximander arrives at a concept of gravity: he calls it "domination". Earth hangs in space without falling because it doesn't have any particular direction in which to fall, and that is because there isn't anything around big enough to dominate it. You and I, being much smaller than Earth, fall towards it. "Up" and "down" are no longer absolutes, they are relative.

The second half of Rovelli's book is less exciting, but more trenchant, perhaps to compensate for covering more familiar territory. It explains how science, evolving out of Anaximander's attitude towards his teacher Thales, developed into a quite unnatural way of thinking.

Thales, in Anaximander's view, was a wise man who was wrong about everything being made of water. The idea of being wise and wrong simultaneously, says Rovelli, can only come from a sophisticated theory of knowledge, "according to which truth is accessible but only gradually, by means of successive refinements".

All Rovelli's wit, intellectual agility and most of his charm are in evidence in this thrilling early work, as he explains how Nicolaus Copernicus perfects Claudius Ptolemy's work by applying his mathematics to a better question, and how Albert Einstein perfects the work of Isaac Newton by pushing Newton's mathematics past a priori assumptions. Nothing is thrown away in such scientific "revolutions". Everything is repurposed. ▮

Simon Ings is a writer based in London

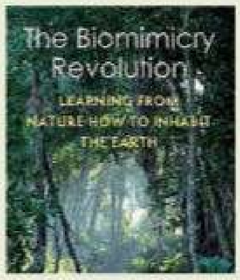
Most of the ideas of Anaximander (second from right) have come to us through the writing of Aristotle

ELLA_CA/SHUTTERSTOCK

Don't miss

Watch

65 sees astronaut Mills (Adam Driver, above) and a crew crash on an unknown planet – with dinosaurs. The sci-fi thriller, by Scott Beck and Bryan Woods (writers of *A Quiet Place*), is showing in cinemas from 10 March.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Read

The Biomimicry Revolution points us towards sustainable ways of living on Earth. Henry Dicks, an environmental philosopher, surveys our use of nature's strategies to improve our surroundings. On sale from 14 March.

Visit

The Use of Algorithms in Society is complex, says Cass Sunstein (above), policy adviser and co-author of the bestseller *Nudge*. He addresses the issues in a talk at Bush House, London, at 6.30pm GMT on 13 March.

PATTI PERRET/SONY PICTURES, AFLO CO LTD/ALAMY

Teeming with life

Cities are amazingly biodiverse, but can we help them exist in harmony with nature before it bites back? **Richard Lea** explores what we need to know

ALEXANDER SPATARI/MOMENT RF/GETTY IMAGES

Tree coverage in New York exceeds the UN threshold for a forest

Book

Urban Jungle

Ben Wilson

Jonathan Cape

THE Kunming-Montreal Global Biodiversity Framework, agreed by about 190 countries last year, pledges to reform environmental subsidies, ensure large businesses declare their effect on biodiversity and conserve 30 per cent of the planet – all by 2030. But the document doesn't mention cities.

In *Urban Jungle: Wilding the city*, historian Ben Wilson shows just what an omission this is. He describes how "real nature" was once thought to exist only in countryside, reserves, mountains and forests. But look closely at the urban environment, he writes, and see how it teems with wildlife.

This explains many strange facts and figures, Wilson says: why New York contains more species than Yosemite National Park in California; why urban gardens support more species than semi-wild rural habitats of an equivalent size; and why Australian cities shelter more endangered species per square kilometre than non-urban areas. Urban areas are just "stunningly biodiverse", says Wilson, "often far more so than nearby countryside".

Generations of ecologists saw suburbia as a "degraded, profoundly unnatural, messed up place", he says, but the complex tessellation of different open spaces on the expanding border between city and country has created "hybrid habitats where the artificial mixes with the natural". The UK and Ireland, for example, boast 1625 native plant species, but there are 55,000 species on sale for domestic gardeners and 70 per cent of plants in a typical garden are non-native. This makes an "alluring habitat for an impressive and increasing array of animals, birds and insects, many of them endangered by intensive farming and climate change".

Wilson acknowledges that urbanisation is "a shocking, destructive event for native wildlife", but thinks it is too late to stop it. "This kind of habitat is a reality, " he argues, "and it is irreversible. Better to embrace it than wish it away. Right in front of our noses is a lavish, vital ecosystem that needs to be valued if it is to thrive."

> **"Wilson imagines a city as no longer a greedy input-output machine, but a functioning ecosystem"**

Urban Jungle is divided into sections covering parks, water, trees and so on, tracing how cities incorporated and transformed the wild, from the marshes of southern Mesopotamia in the 5th millennium BC to 21st-century Amsterdam's ambition to become a circular city – based on the reuse and regeneration of materials.

We hear how the modern suburban garden began with officials returning from British imperial outposts, who modelled their houses on the green cities where they had lived abroad. Also, we discover how advances in siege gunnery created the boulevard, as defensive earthworks were planted with Italian-style double rows of trees – the start of a long arboreal invasion that has left cities like London and New York with twice the tree cover a rural area would need to be defined as a forest by the UN Food and Agriculture Organization.

The separation of the modern city from nature, writes Wilson, is a recent phenomenon, driven by the hubris and pollution of the industrial revolution. This must be reversed if we are to survive the Anthropocene's challenges. He paints a future of patchwork urban expansion, concentrated in "dense, moderately sized hubs set amid substantial patches of remnant vegetation" and "a matrix of habitat highways cutting across the concrete and asphalt desert" so animals can flourish.

He looks forward to parks that prioritise biodiversity as "acts of redemption", and to "zero-acre" agriculture projects in abandoned warehouses that build resilience and reduce the environmental cost of growing food. He imagines a city that is no longer a greedy input-output machine, but a functioning ecosystem "deserving of our protection and nurture".

By splitting his book into sections, Wilson loses the thrust of a linear history, and he doesn't really explain the thinking behind his relaxed attitude to ecological change. But as the world's urban landscape increases by the size of Manhattan Island every day, we urgently need to work out how cities can live in harmony with nature before nature hits back. ▮

Richard Lea is a writer based in London and editor of Fictionable

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FRANK MARTELA

Recharging the brain

A "grand unified theory" of neurodegenerative conditions suggests we may be able to reverse the ravages of brain ageing by retuning or replacing mitochondria, finds **David Robson**

IF YOU own a car, you will have noticed the engine getting less efficient with time. The further you drive it, the more fuel it takes to make the same journey – until, eventually, it becomes so underpowered that it needs a physical push to climb even a gentle hill.

Now, it is emerging that much the same is true of the human brain. Microscopic structures called mitochondria, found in every brain cell, are quite literally the engines of our thoughts and feelings. As we age, they find it harder and harder to produce sufficient energy to power our mental activities. Worse, in a similar way to an old car leaving clouds of smoke in its wake, the cell's powerhouses start generating unwanted waste products that slowly poison our brains. This means that malfunctioning mitochondria may underlie many of the most devastating brain conditions, including Alzheimer's, Parkinson's, Huntington's and motor neuron disease.

According to this "grand unified theory" of neurodegeneration, we could prolong our brain's healthy functioning by recharging our neurons through restoration of their powerhouses. The idea is already inspiring some exciting new therapies for age-related brain conditions, with multiple drug candidates under investigation. Some researchers are even exploring the possibility of transplanting healthy mitochondria into damaged, ageing brains to re-energise them. "If you keep changing the parts of a car, it can last forever," says Claudio Soto, a neurologist at the University of Texas Health Science Center at Houston. "So what happens if we try to do the same with the cell?" As audacious as this sounds, there are already indications that it might just work.

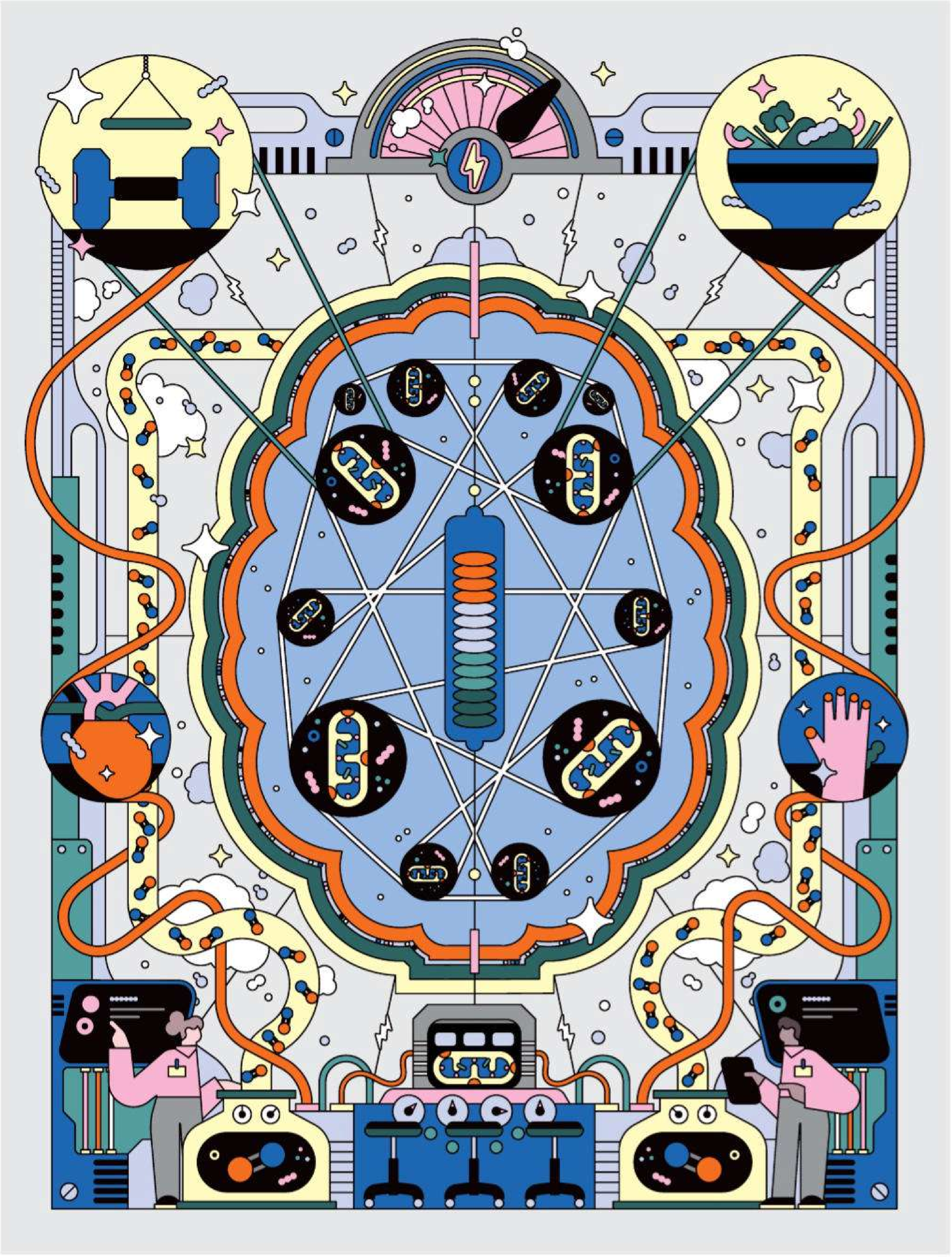
Neurodegeneration is an enormous health burden and, as the world's population ages, the problem is becoming ever more serious. According to the latest estimates, around 152 million people will be living with dementia by 2050, with the major cause being Alzheimer's disease. Parkinson's disease, though less prevalent, is still thought to affect 1 in 37 people over their lifetime. Although some drugs can ease symptoms and slow the progression of these and certain other neurodegenerative diseases, scientists are desperately searching for a better understanding of the causes of these complex conditions.

Microscopic power plants

There is a growing realisation that mitochondria, the engines inside our cells, could be the key. Aside from the nucleus, these tiny organelles – each just a couple of micrometres in length – are the most complex element of cells. In deep evolutionary history, they are thought to have existed as independent life forms, before somehow entering bacteria and beginning a mutually beneficial relationship with them. Mitochondria's ability to generate energy aided the evolution of the multicellular organisms, including humans, that would come to dominate Earth. Today, they are present in each of your cells – except red blood cells – with up to 2 million found in the most energetically active ones.

Like any power generator, mitochondria need fuel, in this case glucose. They use this sugar, after some initial processing in the cell's cytoplasm, to synthesise a molecule called adenosine triphosphate (ATP) that provides useable energy for cellular processes. The brain is the hungriest of all your organs, consuming 20 per cent of the body's energy, but comprising just 2 per cent of its mass. Neurons need a huge amount of energy to fuel electrical signalling and the constant fine-tuning of synapses, the junctions between neurons. That makes them particularly vulnerable to metabolic dysfunction. In recent decades, evidence has been growing that small disturbances in the efficiency of their mitochondria can trigger big problems.

Consider Alzheimer's disease. It is characterised by the build-up of proteins – tangles of tau and amyloid plaques – that appear to be toxic to brain tissue. Historically, this observation has inspired multiple treatments to remove them. Yet several studies show that some people maintain normal cognitive function despite the proteins accumulating in their brains. There are lots of reasons why this might be so, but the most prominent is that these individuals have greater "cognitive reserve", a sort of spare mental capacity that allows them to cope with more damage before showing signs of mental decline. What's more, almost all treatments ›



BRATISLAV MILENKOVIC

that remove plaques and tangles have failed. Despite many years of research, there is no consensus on what causes Alzheimer's.

The possible involvement of mitochondria first came to light in the 1980s, when studies started to suggest that metabolic problems precede the build-up of the protein tangles and plaques associated with Alzheimer's, which then disrupt energy generation further. Brain scans measuring glucose uptake, for example, show that people in the early stages of the condition have markedly slower metabolism. And post-mortem analyses of people who had Alzheimer's reveal that their neurons have around half as many mitochondria as those of people of the same age without the disease.

Like many new ideas in science, this one has taken a while to catch on – and was probably held back by the fixation on protein accumulations as the root cause of Alzheimer's – but the research has now reached a critical mass that is hard to ignore. "There's

> **"The brain is the hungriest of your organs, using 20 per cent of your body's energy"**

Exercise can help keep mitochondria in peak condition as we age

MARTIN PARR/MAGNUM PHOTOS

How to have a younger brain

Your cells are powered by tiny organelles called mitochondria. There is evidence that when the mitochondria in the brain start producing less energy, the result may be neurodegeneration (see main story). Conversely, this may explain why some lifestyle changes help protect the brain from the effects of ageing.

The first is exercise. We tend to associate physical activity with heart health, but abundant research shows it can also reduce your risk of neurodegeneration. This may be because it stimulates mitochondria throughout the body, ensuring that they are in peak condition to meet the demands of our energy-hungry brains.

According to some studies, a calorie-restricted diet appears to have similar effects. This involves reducing energy intake by around 20 per cent and, in animal studies at least, is linked to greater longevity and improved brain health into old age. Experiments on animals suggest that this may be due to improved mitochondrial efficiency.

You may have also heard about the ability of resveratrol – a compound found in the skin of grapes – to promote healthier ageing. Studies show that it can stimulate the replacement of old, malfunctioning mitochondria with new ones, providing one possible explanation for its benefits. The same goes for some other supplements that seem to show promise in reducing the risk of neurodegenerative conditions, such as turmeric, ginseng and *Ginkgo biloba*.

now a lot of evidence from animal models and cell cultures which prove that there's reduced mitochondrial function with Alzheimer's disease," says Reham Abdel-Kader at the German University in Cairo, Egypt. Adding weight to this, we have also discovered that the main gene variant known to increase the risk of Alzheimer's, ApoE4, reduces the efficiency of mitochondria. One study, for example, found that the neurons in mice with this gene variant produced less ATP, and their memory and ability to learn were compromised.

That still leaves the question of where protein tangles and plaques come in. According to one leading idea, the stress of meeting the neuron's energy demands causes mitochondria to start producing more waste products, which triggers the production of tau and amyloid. To make matters worse, the cell's energy crisis may prevent a rapid clean-up of these toxic proteins. "When a cell is metabolically stressed, a lot of the non-essential functions can be slowed down, one of which is clearance of waste macromolecules," says Yashar Kalani at the University of Virginia. Experiments suggest that these piles of garbage can damage the mitochondria, which contributes to an even greater energy crisis, setting off a vicious cycle that descends into widespread neurodegeneration. Cognitive reserve may help some people cope better with this. But if the underlying mechanism does indeed relate to metabolism, that would explain why treatments to remove plaques usually fail to improve cognition in people with Alzheimer's symptoms.

Parkinson's disease may emerge through similar pathways. The condition is caused by a loss of neurons producing the neurotransmitter dopamine, which is used for communication with the part of the nervous system controlling the muscles. As these neurons die and dopamine dries up, people with Parkinson's struggle to execute precise movements. The cell loss coincides with the build-up of a protein called alpha-synuclein, which forms sticky lumps known as Lewy bodies that are usually associated with Parkinson's. Much like the research on Alzheimer's, multiple lines of evidence now point towards mitochondrial dysfunction as the underlying cause of these changes.

SEBASTIAN KAULITZKI/ALAMY

Protein plaques in the brain may be caused by failing mitochondria

Suspicions of a link were first aroused by the observation that some people develop Parkinson's-like symptoms following exposure to certain pesticides, such as rotenone, which are known to impair mitochondrial function. Analyses of the main genes behind hereditary cases of Parkinson's disease bolstered this hypothesis: PINK1, parkin and LRRK2 are all involved in the health and maintenance of mitochondria and their disposal when they are no longer functioning effectively. Once again, it seems that impairments in metabolism might lead to the formation of the toxic proteins in those Lewy bodies, which could then cause further stress to the mitochondria.

Evidence of mitochondrial dysfunction in Huntington's disease and amyotrophic lateral sclerosis (a form of motor neuron disease also known as Lou Gehrig's disease) further supports the idea that a dwindling energy supply may be an underlying cause in most neurodegenerative conditions. And the fact that mitochondrial efficiency drops as we age neatly explains why they tend to emerge in later life.

Malfunctioning mitochondria might also help us understand why long-term inflammation – arising from stress, poor diet or a disrupted immune system – increases vulnerability to neurological illness. Research shows that certain inflammatory chemicals called cytokines impair energy generation in mitochondria and, conversely, that mitochondrial dysfunction can trigger inflammation. In other words, inflammation seems to be another cog in the vicious cycle leading to brain deterioration. This idea can also help explain why certain lifestyles appear to slow brain ageing (see "How to have a younger brain", page 40).

Unsurprisingly, neuroscientists are already looking for ways to bolster struggling mitochondria, with the hope of preventing neurodegeneration or at least slowing its progress once it starts. They have been excited to discover that a handful of existing drugs may achieve this. One is terazosin, commonly prescribed to treat the urinary problems that arise from an enlarged prostate. It transpires that the drug also binds to an enzyme called PGK1 that is involved in breaking down glucose and producing ATP. This boosts the enzyme's activity and hence the overall productivity of mitochondria. Two related drugs, doxazosin and alfuzosin, offer a similarly unexpected increase to energy production.

Energy-boosting drugs

The clincher came in 2021 with the discovery that men taking one of these three treatments for an enlarged prostate had an up to 37 per cent reduced risk of developing Parkinson's compared with those on another drug that didn't boost energy production. "We also found that the longer the people were on these drugs, the lower their risk," says Jacob Simmering at the University of Iowa. His colleagues are now planning a clinical trial to test the drugs on people who are at a high risk of Parkinson's. And their ambitions don't end there. "We don't think this is necessarily a Parkinson's-specific intervention," says Simmering. "Given that our metabolism slows as we get older, could we reduce the risk of other age-related diseases ›

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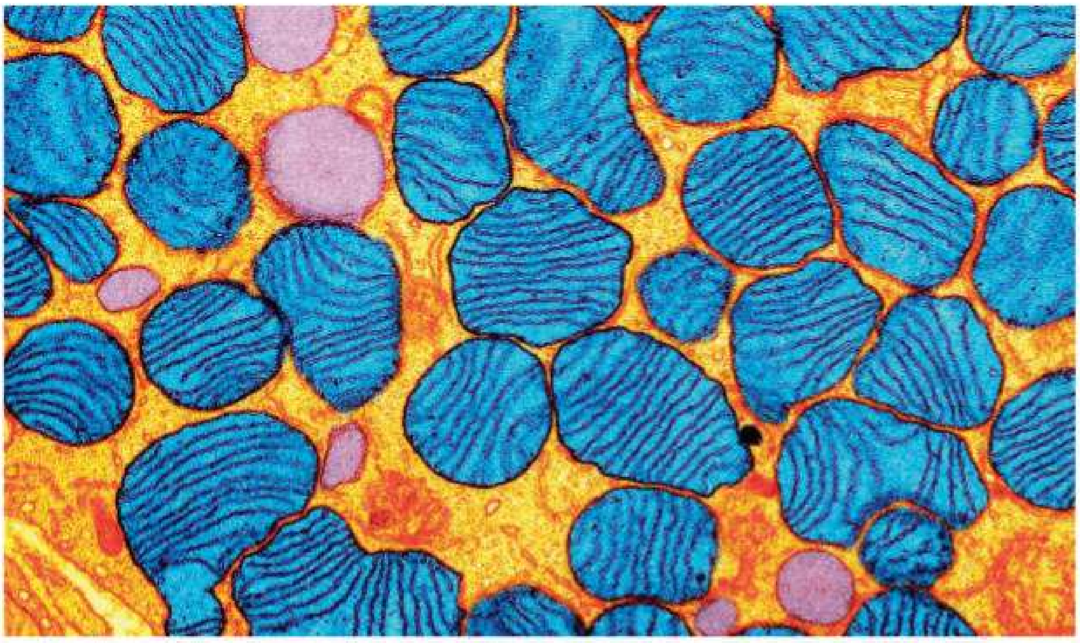
through this mechanism? It's something that we're considering as a plausible idea."

The harder scientists look for drugs to boost mitochondrial activity, the more they seem to find. Erythropoietin is another. Despite it being banned in sports, some athletes use it to enhance performance because it increases their number of red blood cells, which carry oxygen to muscles. But animal studies suggest that it can also reverse some of the mitochondrial damage in Parkinson's and Alzheimer's. Meanwhile, Abdel-Kader is exploring the potential of nitric oxide, a signalling molecule that has been shown to stimulate the growth of mitochondria when present at the right doses. She and her colleague Salma Tammam, also at the German University in Cairo, have designed biodegradable nanoparticles to deliver the gas to the brain in a controlled way. In early tests, their team found that nitric oxide improved the memory of mice with a form of neurodegeneration that is similar to Alzheimer's disease.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A transmission electron micrograph of mitochondria (blue) in a fat cell

Mitochondrial transplants

Other researchers have set their sights on an even more ambitious solution to the brain's energy deficit: a therapy known as mitochondrial transplantation, which involves harvesting organelles from healthier tissue and transferring them into damaged parts of the brain. That may sound far-fetched, but a team led by Keren Nitzan at Hadassah University Medical Center in Jerusalem has found that an injection of healthy mitochondria from humans can improve the memory and learning ability of mice with an Alzheimer's-like illness, with cognitive benefits lasting at least 13 days. Furthermore, mitochondrial transplantation is already being trialled in humans – although not in the brain. In 2018, for instance, doctors at Boston Children's Hospital in Massachusetts reported successfully using mitochondrial transplantation in the heart to aid recovery from oxygen starvation after cardiac surgery.

Kalani is one scientist seeking to use this therapy to treat ageing brains. He is first going to test mitochondrial transplantation in people who have had a stroke. The idea is to take a tiny piece of muscle tissue during surgery near the incision site. While the surgeon is operating, this will be centrifuged to extract mitochondria. "It can be done pretty rapidly – in about 20 minutes," says Kalani. As muscle is rich in mitochondria, a small biopsy could provide around a billion of them. They will then be released directly into the brain through the same catheter used to break up the blood clot, in an attempt to help oxygen-starved brain tissue recover. If this works, the same method could be used to release mitochondria into the brains of people with neurodegenerative conditions like Parkinson's or Alzheimer's, says Kalani.

One major obstacle is getting mitochondria through the walls of blood vessels in the brain, which are notoriously impermeable. To get around this problem, Kalani has successfully used focused ultrasound to disturb the "blood-brain barrier" so it becomes temporarily more porous. Another possibility is to spray mitochondria into the nose or inhale them through it, where they can travel along the olfactory and trigeminal nerve pathways. "There's a direct connection," says Soto, which means the mitochondria would bypass the blood-brain barrier altogether. An early feasibility study, published in 2021, found that this technique reduced the symptoms of Parkinson's in rats with a version of the disease.

There is also the question of where to get the mitochondria. Will it be good enough to take them from a patient's muscle, as Kalani suggests, or should they come from a healthy donor or be cultivated from stem cells? Each has potential advantages and disadvantages that must be tested. We still need to determine the safety of these procedures and the size and duration of the benefits, says Kalani. But he is optimistic. "This has huge potential," he says. "I think the opportunities are very exciting."

It does look that way. As our understanding grows, we should be able to identify many other ways to keep the hungry "engines of thought" running smoothly. Even if only a few of these succeed, they will provide huge relief for millions of people at risk of developing neurodegenerative conditions. "There is a lot of promise," says Soto. ■

David Robson is the author of *The Expectation Effect: How your mindset can transform your life*

ISRAEL SEBASTIAN/GETTY IMAGES

The unlikely rise of liquid sponges

Creating absorbent liquids seemed impossible. But now they are here and they could be surprisingly useful, says **Katharine Sanderson**

HAVE you ever stopped to consider the technological marvel that is the humble kitchen sponge? Liquids tend to be unruly, sploshy things, but, with a quick swipe, a sponge can soak up and transport them to wherever they are needed. It would all be rather miraculous were it not so familiar.

But here's a question that is a little more out of the ordinary: could we make a liquid sponge? It would be kind of like the household variety, only it would suck up gases instead of liquids and it could be pumped over vast distances. That would make it incredibly useful. After all, we are in the middle of a climate emergency caused by the emission of greenhouse gases such as carbon dioxide and methane. A liquid sponge could provide a better way of sucking up those gases and preventing them from causing harm.

You might expect the concept of a spongy liquid to be a non-starter. As most of us learned in school, a liquid is something that fills up the bottom of any container it is poured into – no holes or spaces allowed. Yet in labs around the world, chemists are creating a rich assortment of cleverly designed liquid sponges and putting them to the test. We are about to find out just how useful this quirky technology really is. ›

The story of liquid sponges – sometimes called porous liquids – begins in 2007 when chemist Stuart James began working at Queen's University Belfast in the UK. He was researching solids known as metal-organic frameworks (MOFs), cage-like compounds made of metal ions and carbon-based molecules. The special thing about them is their extraordinary porosity: a single gram of a MOF can have pores in it with an internal surface area as large as a football pitch. In other words, MOFs are super sponges, the chemical structure of which can be tweaked so that they absorb very specific things. They can be used to mop up environmental toxins, for example, or to suck water vapour from the air.

There is a problem with MOFs, however, as James discovered one day when he got talking to his colleague David Rooney, a chemical engineer. Rooney pointed out that engineers like him are loathe to work with solids because they are so awkward to handle when it comes to large-scale industrial chemistry. It is much easier to deal with large volumes of liquids than solids because the former can be easily pumped and stirred.

Melted cages

It got James pondering if it would be possible to turn a MOF into a liquid. From the start, he knew it was an outlandish thought. Scientists design the structure of solid materials all the time by controlling where the constituent molecules sit in relation to each other. But in a liquid, those molecules are tumbling all over the place, so designing the structure of a liquid to be sponge-like sounds preposterous. James says that, at the time, he wondered: "Is it bonkers to think that you can actually design a liquid from the molecules?"

Within a few months, he had published a concept for how it could be done. All liquids have tiny and constantly shifting gaps between their molecules. This is why fish can breathe the oxygen dissolved in water: it is carried in these spaces. But James's plan was to create liquids made of molecules that were, like MOFs, empty cages. This way, the liquid would be far more absorbent, with bigger holes, and could potentially hold much more significant amounts of gas.

James thought the simplest way to make a porous liquid would be to take a powdered MOF and melt it. He dubbed this a type 1 porous liquid and started trying to make one, working with Andy Cooper at the University of Liverpool, UK. The trouble was, many MOFs are only liquid at high temperatures, often above 200°C, making them impractical. The researchers also found that the cage-like molecules would often break down when heated that much. "It was a brilliant idea," says James. "Unfortunately, it didn't work."

He quickly came up with a possible workaround, however. One way to turn a solid into a liquid is to melt it – but another is to dissolve it, like the way we stir sugar into a cup of tea (see "Almost the last word", page 54). There could be another kind of porous liquid, a type 2, reasoned James, comprising a cage-like molecule dissolved in a solvent.

To see why achieving this was anything but straightforward, picture the cage molecule and the solvent molecules as a mixture of doughnuts and wiggly strands of spaghetti. The trouble is that the holes of the doughnuts – the pores of the liquid sponge – can easily get clogged up by strands of spaghetti, preventing the liquid from soaking up anything else.

> **"Separating chemicals accounts for 10 to 15 per cent of world energy use"**

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Carbon-capture-and-storage technology in use at an oil refinery in Hokkaido, Japan

To get around this, James and his colleagues moved away from the metal-based MOFs and instead used large, cage-like molecules made predominantly of carbon atoms, which could be chemically tweaked more easily. They tried a huge range of different designs, but still had problems with the solvent getting inside the cage. Then, in 2015, they hit upon the idea of using an unusual solvent made of molecules called crown ethers. These aren't shaped like spaghetti strands, but more like large dinner plates. They hit the sweet spot of both dissolving the cages and being so big that they couldn't block the pores within the cages. This strange concoction of cage-like molecules dissolved in crown ether was the first porous liquid.

Working with Margarida Costa-Gomes at the University of Lyon in France, James tested how good this liquid was at absorbing gas, comparing it with the neat crown ether. The results, published in 2015, were impressive. "Having the empty spaces increased the solubility of methane [in the liquid] by about a factor of eight," says James.

Since that proof of concept, James and Cooper have been creating other porous liquids. One thing they have been working on is getting the viscosity of the liquids to be as low as possible – think cooking oil rather than treacle – to make them easier to pump. They have also patented their concept and started a company called Porous Liquid Technologies.

Last year, the company began running its first pilot-scale rig to make and test porous liquids, down the road from James's lab in Belfast. The first goal is to test the ability of the liquid sponges to selectively suck up CO_2 being given off by an anaerobic digester, essentially a tank of bacteria used to break down organic material such as food waste. This process gives off a range of gases – methane, hydrogen and CO_2 among them. Ideally, we would separate and capture these so they can be reused. This does happen to some extent at the moment, through a process that involves solvents based on chemicals called amines. But it guzzles large amounts of energy, mainly because getting the greenhouse gases back out of the amine solvent is such hard work.

In the pilot rig, mixed gases from a digester get funnelled into a column containing the porous liquid, which selectively absorbs the CO_2. The liquid sponge then gets pumped into another container, where it is heated and put under vacuum so that the CO_2 is "wrung out" of it. James says that initial tests suggest the liquid sponge can extract the CO_2 using 17 per cent less energy compared with the existing method. "It's a very exciting time," he says.

There is plenty of scope for liquid sponges to save us energy in other ways too. It is estimated that separating chemicals accounts for between 10 and 15 per cent of the world's energy use. "There is an urgent need for advances in chemical separation processes and materials," says chemical engineer Ryan Lively at the Georgia Institute of Technology in Atlanta. "And porous liquids are an important new direction." In time, James is hoping to develop a range of these liquids, each with different properties to suit various applications (see "Three more things we could do with a liquid sponge", right).

Jarad Mason at Harvard University was also intrigued by porous liquids, but noticed that they were nearly all based on organic solvents – that is, solvents made of carbon-based molecules. To Mason's mind this was a serious limitation because it ruled out using them in any living system. Organic solvents are at best incompatible with cells and tissues, and they can be highly toxic. "Anything you want to do that involves a biomedical application is going to have to take place in an aqueous environment," he says.

Mason and his colleagues set out to make a water-based liquid sponge. But there was an immediate problem. Water is a tiny molecule, far smaller than most organic solvents, and this meant any cage-like molecules dissolved in water could easily have their pores plugged by the water, stopping them absorbing any gas. To circumvent this, Mason and his colleagues took tiny particles of MOFs and chemically modified them by adding groups of atoms on the outside that were water-loving and other groups of atoms on the inside of the cavity that were water-hating. This created cage-like molecules that were happy to dissolve in water, but each had a pore that water molecules couldn't easily occupy.

To test the performance of this liquid sponge, Mason and his team sucked the air out of their MOF-water solution and measured how much of it was oxygen. They then did the same with a sample of pure water. The liquid sponge held 100 times more oxygen. They also showed that the oxygen could be released again by bubbling their oxygen-loaded liquid sponge through deoxygenated blood. "You can see the solutions go from like really dark red to bright red as the red blood cells become oxygenated," says Mason.

Three more things we could do with a liquid sponge

CAPTURING CARBON

Carbon-capture-and-storage technology is used to try to sequester greenhouse gases produced at fossil fuel power plants and other high-emitting industries, such as steelworks. Porous liquids could be a cheaper, more efficient way of soaking up the carbon dioxide than the current technology.

PURIFYING CRUDE OIL

The process of separating crude oil into all its components – natural gas, petrol, bitumen and more – currently relies heavily on distillation, which requires a huge amount of energy to heat up the mixture. Porous liquids could be an alternative, lower-energy separation technology.

HARVESTING XENON

Xenon is a rare gas used in physics experiments, as an anaesthetic and in lights. We currently obtain it by liquefying air and then distilling it, an energy-intensive process. Porous liquids could be used to separate xenon from nuclear waste instead.

He is currently exploring how these biocompatible liquid sponges could be used. One idea is that, in a medical emergency, they could be injected into people who aren't breathing. It would be a quicker way of getting oxygen into their bloodstream than relying on mechanical ventilation. But their scope could be far wider than this. Using water-based porous liquids in industrial processes – for example carbon capture and storage – would be good because water is such an environmentally friendly, low-impact solvent.

Recently there has even been progress towards making a type 1 porous liquid, the ideal, undiluted sort that James dreamed up in the early days. James decorated his MOF cages with long tails to make them liquid at a lower temperature – but those tails tended to get tangled up in the cages' cavities, thwarting their capacity to absorb gas.

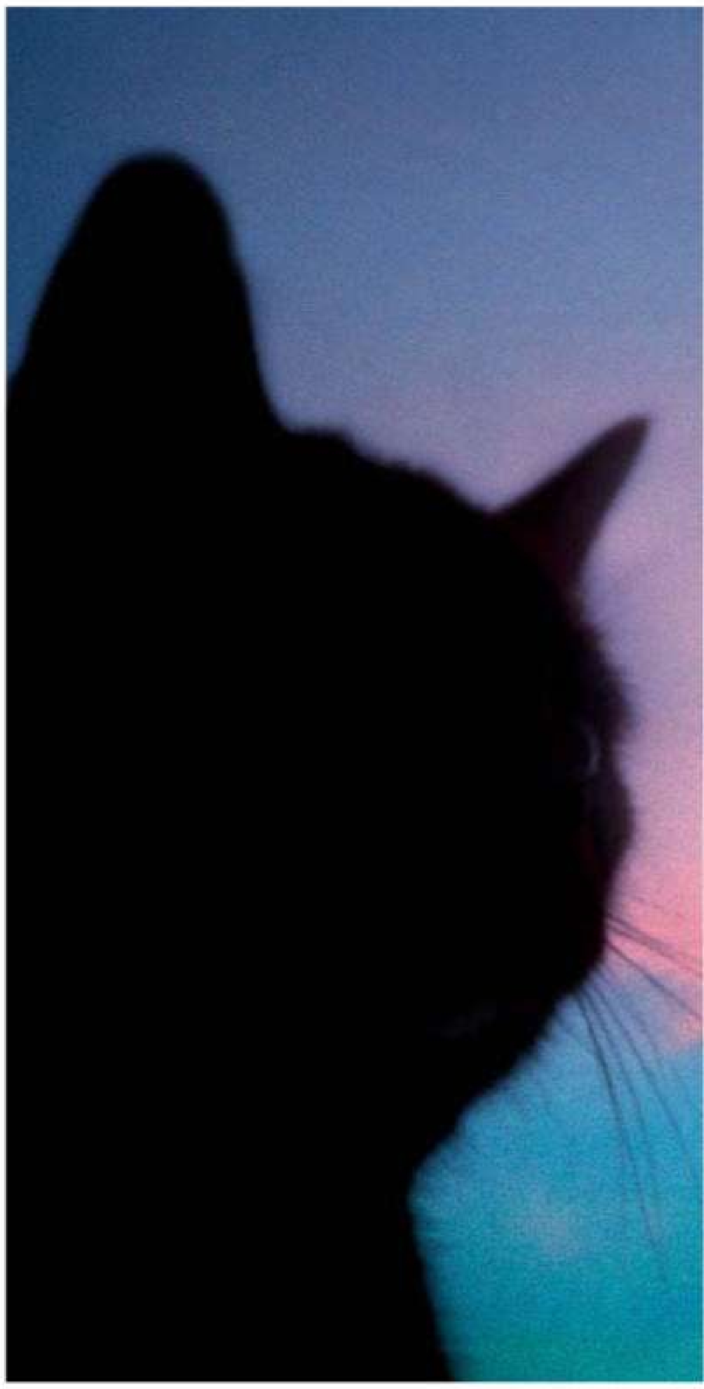
Jonathan Nitschke at Cambridge University instead constructed a cage molecule from one positively charged component and one negatively charged component. This so-called ionic liquid proved to be a fluid below room temperature. Furthermore, the charges repelled the cages from each other, ensuring that the gaps inside them remained accessible to gas molecules. It was the first example of a type 1 porous liquid and Nitschke showed that it could suck up CFCs, the chemicals responsible for creating a hole in the ozone layer.

Nitschke admits that his creation has the consistency of honey – not great for pumping through pipes. This underlines the fact that liquid sponges still have a way to go. Nonetheless, porous liquids are beginning to slosh into action. Before long, they could be helping to soak up the mess we have made of our planet. ▮

Katharine Sanderson is a science writer based in Cornwall, UK

The truth about cats

Aloof and untamed? Science is revealing that felines have been misunderstood, discovers **Michael Marshall**



SERGEY RYUMIN/GETTY IMAGES

ON A regular basis, I wonder why we have a cat. This thought was most recently prompted by Peggy jumping onto a dresser and knocking off a ceramic bowl, which smashed. By the time you read this, she will have done something else to make me question my choice of pet.

Unlike dogs, which are dependent on us for everything, including their emotional well-being, cats seem to be sociopaths. Most cat owners (if owner is even the word) have entertained the suspicion that our feline companions would abandon us if we found ourselves unable to open their food containers. Sure, Peggy comes for cuddles every so often, but she might just be looking for warmth. In fact, despite cats having lived among people for thousands of years, it is questionable whether this has done anything to tame them.

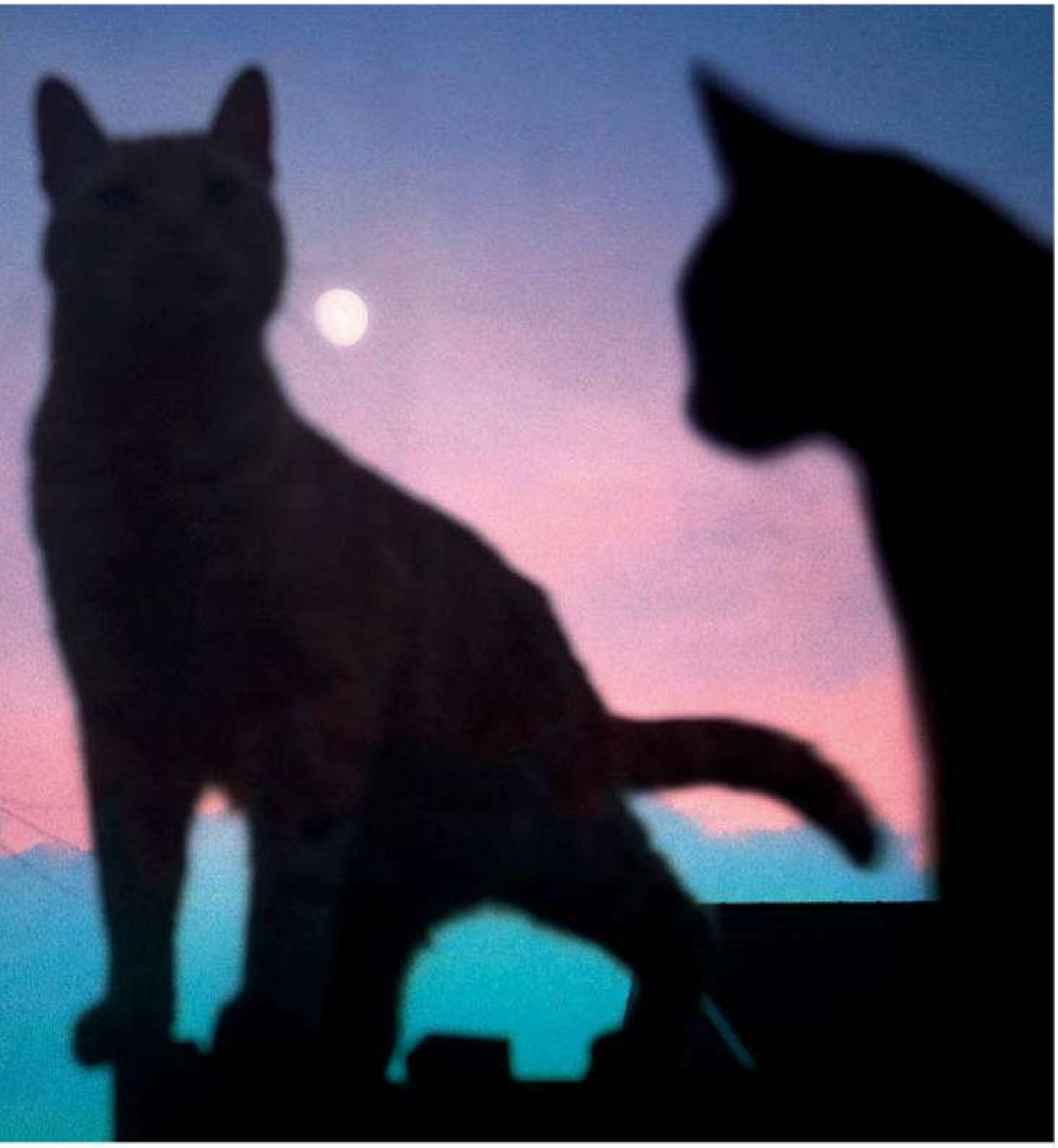
However, it may be that cats are just misunderstood. Compared with dogs, they express themselves far more subtly, so that many of us don't understand what their gestures and behaviours mean. Recent experiments suggest that cats are more socially intelligent and attuned to familiar humans than we realise. These studies even indicate that cats like us (I know, I can't quite believe it either). What's more, genetic investigations are getting a grip on just how domesticated cats really are. The findings may make you see your moggy in a whole new light.

Cats and dogs are the most popular pets in the world, yet the two behave very differently towards us. Dogs will rush to the front door in excitement when you come home, whereas cats appear aloof and indifferent. The story of how these species came to live alongside humans offers some answers as to why.

For a start, the wild ancestors of cats were fairly solitary, whereas dogs evolved from wolves, which are highly social creatures. Felines seem to have started on the path to domestication around 10,000 years ago in the eastern Mediterranean, sometimes called the Near East. Archaeological evidence includes a 2004 report that a cat had been buried with a person on the island of Cyprus, in a grave dating to 9500 years ago. This ancient link between cat and human is supported by growing genetic evidence.

Leslie A. Lyons at the University of Missouri has collected DNA from cats for three decades and looked at a range of genetic markers to explore their evolutionary history. "In the end, the story is all the same," she says. In 2008, her team compiled DNA samples from more than 1100 individuals from five continents. "The highest diversity tends to be in the Near East," indicating that this is where the population originates, she says. Similarly, in a study from November, Lyons and her colleagues obtained DNA from over 1000 cats, and again found that the eastern Mediterranean was the site of their domestication.

The timing is significant. Cats started hanging out near humans around the time that people in the eastern Mediterranean started farming, instead of hunting and gathering. This change in lifestyle meant people accumulated stores of grains like wheat. "It attracted rodents and other pests,"



MAYA BEANO

says Danijela Popović at the University of Warsaw in Poland. "The increased number of rodents attracted the cats."

In other words, there is no reason to suppose that humans deliberately domesticated cats. "Cats found it is good to be close to the people because the food is there," says Popović. "Also, people found it is good to have cats around." If anything, cats domesticated themselves.

Evolving situation

In 2014, a team that included Lyons described the first complete genome sequence of a domestic feline, obtained from an Abyssinian cat called Cinnamon. Compared with wildcats, several regions of this genome showed signs of having evolved under natural selection. They included genes thought to be involved in fear conditioning – the ability to develop fear responses to previously innocuous stimuli – and learning about rewards. The key transition seems to have been that some cats became more tolerant of humans, perhaps because they were bolder or less afraid. Those cats were able to thrive on mice – and so evolution favoured cats that were less scared of humans.

As time went on, the human-cat relationship deepened. In ancient Egypt, people often mummified cats. Lyons and her colleagues have used DNA recovered from them to show that they were domestic, not wild. Later, the Roman Empire would carry domestic cats far and wide.

In a study published last November, Popović and her colleagues found evidence that African wildcats may actually have roamed as far north as Poland 8000 years ago – or perhaps that they interbred with Eurasian cats, which picked up some of their distinctive DNA as a result. This may explain a 2018 study showing that cats living in central Europe already carried some of the genetic markers found in domestic cats, 2000 years before the Romans.

The wild ancestors of domestic cats are referred to as African wildcats or Near Eastern wildcats, depending on who you ask. The confusion arises because the various wildcat ›

Communing with kitty

Can cats talk? The short answer is no, but they may be better at communicating than we assume.

Gabriella Smith at the Messerli Research Institute in Vienna, Austria, is one of several researchers involved with TheyCanTalk, a citizen science project testing the communication abilities of domestic animals, including cats (though so far, most of the focus has been on dogs).

The idea is to see whether the animals can learn to push buttons to communicate simple but specific messages – in particular, their desires. "So pressing the 'outside' button functions to request going outside," says Smith, "or to press 'water' functions to bring to your attention that there's something up with the water."

Compared with dogs, we know less about cat communication, partly because cats are more difficult to work with: they are territorial and less willing to be bribed with food treats. Hence the citizen science approach: "It's to our advantage to study cats in the home" where they behave naturally, says Smith. Around 300 cats are enrolled so far.

This project is still in the very early stages, but assuming cats can learn the right buttons to press, it will immediately raise another question: what do they understand about what they are doing?

"There doesn't have to be the intention of communication there," says Smith. A cat might simply learn that pressing a particular button is associated with the door opening, without grasping that this only happened because a human got the message.

ZOBO/SHUTTERSTOCK

> **“Cats don’t make big demonstrative gestures in the way that dogs do”**

species and subspecies all interbreed to some extent. This mating free-for-all continues to the present day.

It is only in the past 200 years that humans have started selectively breeding cats, generally to produce particular appearances rather than for practical purposes. But most cats aren’t part of these breeding programmes and mate as they please – in contrast to dogs, which, for centuries, have been selectively bred for purposes ranging from hunting to fitting in handbags. And unlike dogs, most cats still go out and perform their natural behaviours like hunting. In fact, cats have considerable control over their daily routines compared with other domesticated animals. “This is where we get into cats being semi-domesticated,” says Lyons. “If cats were all turned loose, they would probably do pretty good, just living on their own and going out and hunting birds and mice and rats and lizards, and surviving.” This means that there simply isn’t such a strong need for cats to be in tune with humans.

This doesn’t stop us anthropomorphising them in a big way. Have you ever wondered if you are alone in talking to your cat in the same high-pitched, happy voice that we use to address babies and children? Dog owners talk to their pets in this way, and in a study published last year, Charlotte de Mouzon at Paris Nanterre University and her colleagues showed that cat owners do it too. “We recorded humans talking to their cats,” she says, “and everybody was doing it.”

Are we kidding ourselves? Maybe not. Close study of the behaviour of cats reveals that they are more attuned to us than we realise, and it isn’t just cupboard love. “There are a lot of stereotypes surrounding cat behaviour,” says Kristyn Vitale at Unity College in Maine. “However, many of these ideas are not supported by the current science.”

Cats know when we are talking to them, for example. In a study from October last year, de Mouzon and her colleagues recorded cat owners talking, both in the high-pitched voice and normally. They also recorded strangers saying the same things. When the cats heard their owners talking in the high-pitched voice, they changed their behaviours: variously looking around, becoming still or moving their ears and tails. However, they didn’t react to the strangers talking in the high-pitched voice. “They don’t consider all humans the same,” says de Mouzon. “They really have a special feeling when their owner is addressing them.”

This is just one approach that is shining light on feline social skills. In the past few years, a group of Japanese researchers has made a string of surprising discoveries. In 2019, research co-led by Atsuko Saito at the University of Tokyo found that pet cats recognise their names; their ears and tails moved differently when they heard recordings of their owners saying their names compared with other words that sounded similar. But your pet cat will still probably ignore you when you call it. “Cats are not evolved to respond to human cues,” Saito told *New Scientist* at that time. “They will communicate with humans when they want. That is the cat.”

Cat map

Other research has revealed that cats are attuned to their owners in other ways. In 2021, the Japanese team, this time led by Saho Takagi at Kyoto University, showed that cats can mentally “map” where their owners are in the room just by listening to their voices. When recorded voices were played from different speakers, making it sound like the human had teleported from one side of the room to the other, the cats moved their ears and looked around – seemingly surprised. “That is how carefully they listen to humans,” says Takagi.

Similarly, in a study posted online last September, de Mouzon and her colleague Gérard Leboucher, also at Paris Nanterre University, found that cats approached more quickly if the researchers said their names and offered their hand, compared with only one of these modes of communication. This indicated that the cats could integrate multiple signals from humans. Furthermore, Takagi and her colleagues have found that cats display

An inexplicable love of boxes

It is a curious fact that all cats love sitting in boxes. Not just domestic cats: big cats like tigers do it too.

It “makes a lot of sense” if you think about cat behaviours, says Gabriella Smith at the Messerli Research Institute in Vienna, Austria. A box exerts gentle pressure on the cat’s sides, which might be similar to the feeling of cuddling up with littermates as a kitten. “There’s also the fact that cats are ambush predators,” she says. “Maybe they are attracted to boxes because they can hide and sneak up on things.”

So far, so sensible, but why do cats also like sitting on pieces of paper, or flat surfaces that look like boxes?

This was documented on Twitter in 2017, when many cat owners taped the outlines of shapes onto their floors and watched their cats promptly sit inside. The hashtag #CatSquare trended and the phrase “if I fits, I sits” entered common parlance.

Four years later, Smith and her colleagues published a citizen science experiment confirming that cats will sit inside a Kanizsa square, which uses four circles, each with a quarter cut out, in an arrangement that creates the illusion of a square. She doesn’t know why. “The jury’s still out on that one.”

However, Charlotte de Mouzon at Paris Nanterre University says there may be a prosaic explanation. “If you put something new in the house, [cats] will need… to put their scent on it to mark it,” she says. This helps them feel secure in their environment. “And sitting on something is a way to put their scent for cats,” she says.

Why do cats, even big ones like tigers, enjoy being in boxes so much?

CHRIS WINSOR/GETTY IMAGES

KARINE AIGNER/NATUREPL

ANN & STEVE TOON/NATUREPL

Domestic and wild: A cat cafe in Kyoto, Japan, and an African wildcat in South Africa

Try this at home

Here are some tests to attempt with your cat, based on simplified versions of experiments to explore cat cognition.

DOES YOUR CAT KNOW THEIR NAME?

Say your pet's name, and compare its response with when you say another word using the same tone of voice. If your cat knows its name, it should move its ears, head or tail more frequently compared with when it hears the other word, or it will make a sound itself.

CAN YOUR CAT READ YOUR GAZE?

Place an item of food in one of two bowls in different locations. Get your cat's attention by calling them, then turn your gaze to the correct bowl. In tests, cats were able to follow the gaze to the correct bowl 70 per cent of the time. Gaze is important for social animals, but it wasn't known if cats had this ability.

DOES YOUR CAT FALL FOR AN OPTICAL ILLUSION?

Create an illusion of a square (known as the Kanizsa illusion) by cutting quarters out of four black discs and arranging them as the corners of a square. Many cats are susceptible to this trick and will sit in the illusory square.

jealousy – which they tested by comparing the cat's reaction when their owner petted a realistic-looking toy cat (a potential rival) or a furry cushion.

Perhaps the most striking evidence comes from Vitale. In a 2017 study, she and her colleagues presented cats with a choice of four stimuli: food, toy, scent or interaction with a human. For most cats, humans were their favourite, with food coming second.

Vitale followed that up with a 2019 study in which she explored the nature of cats' emotional attachment to their owners. She used a test that is also deployed, with modifications, on human infants. One by one, 70 kittens aged 3 to 8 months were taken into an unfamiliar room by their owners. After 2 minutes, the owner left and the kitten was left alone for 2 minutes. Then the owner returned. Most of the kittens – 64 per cent – displayed a secure emotional attachment.

When their owners returned, the kittens promptly interacted with them and seemed pleased to see them, then, reassured, confidently resumed exploring the room. This mirrors what is seen in human infants who have secure relationships with their parents and caregivers. "Secure cats see their caregiver as a source of comfort and security," says Vitale. "This study demonstrates that cats can form strong bonds with humans."

It seems that we have misunderstood our cats. Some of the confusion has arisen because they don't make big demonstrative gestures in the way dogs do, says de Mouzon. "They are very subtle animals." Cats haven't evolved the muscles to raise their eyebrows to make puppy-dog eyes, for example. But evidence accumulated over the past decade shows that cats have, despite appearances, developed many social skills to help navigate their human-centred world.

I wonder whether cats are changing, gradually becoming more domesticated as they spend more time indoors in suburban houses and less time on farms. Unfortunately, there is currently no way to tell: nobody carried out behavioural tests on cats in the Middle Ages (when, according to a recent analysis of manuscripts from that time, they played a central role in daily life). And we don't yet have a time series of DNA from cats from different centuries to see if they are still evolving.

But what is clear is that cats like Peggy do feel an attachment to their human attendants. As I sweep up the remains of the bowl that she broke, that is reassuring to know. ∎

Michael Marshall is a freelance writer based in Devon, UK, and a devoted servant to tabby cat Peggy

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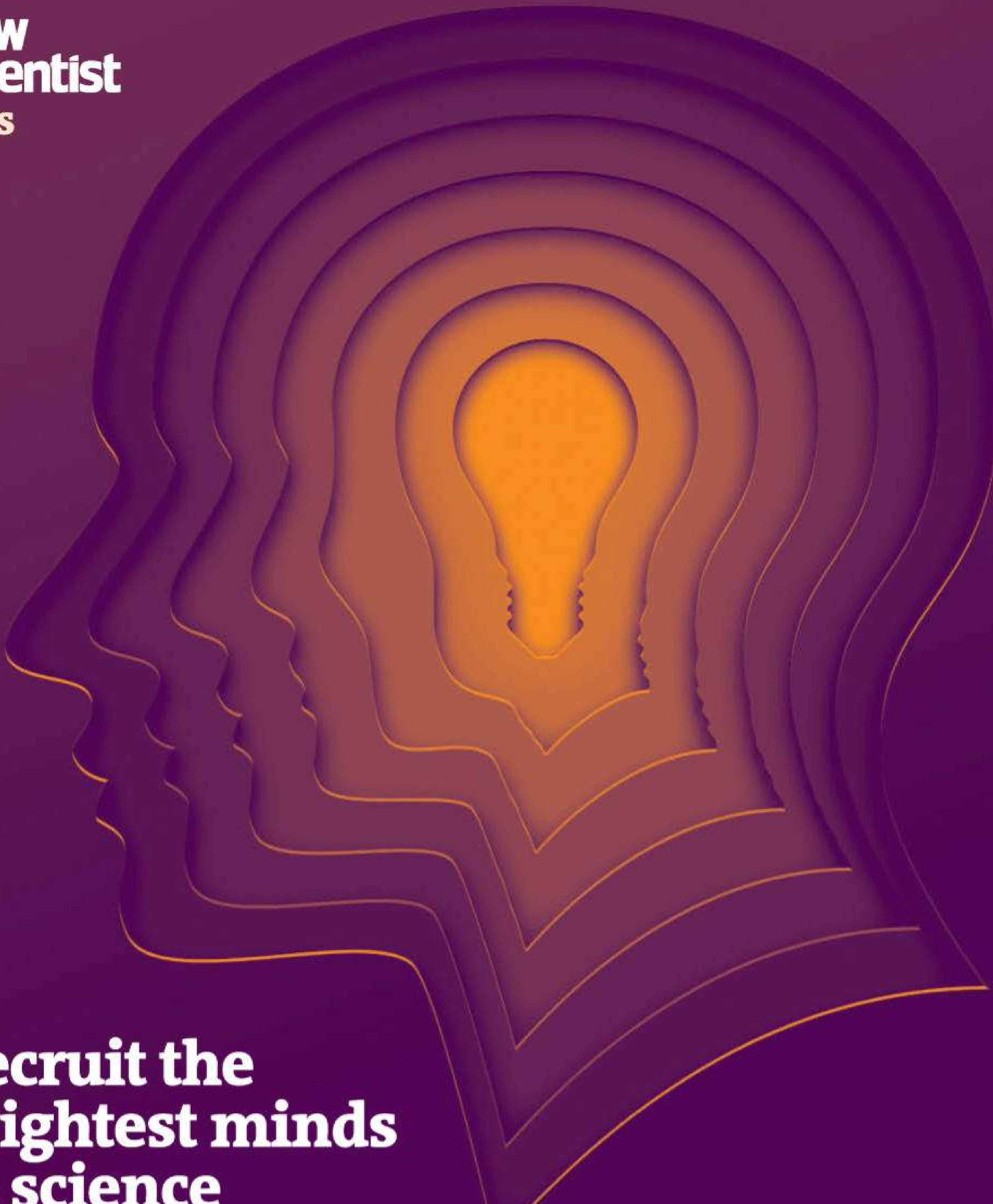

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Science of gardening

Super worms

Earthworms are a great indicator of soil health. Here's how to assess your garden's population, says **Clare Wilson**

Clare Wilson is a reporter at *New Scientist* and writes about everything life-science related. Her favourite place is her allotment garden @ClareWilsonMed

What you need

Organic matter, such as leaf litter, for adding to the soil

Science of gardening appears every four weeks. Share your gardening successes with us on Twitter and Instagram @newscientist, using the hashtag #NewScientistGardening

Next week

Citizen science

PHOTOGRAPHYFIRM/SHUTTERSTOCK

IN MOST parts of the world, earthworms are seen as the gardener's friend because of the many ways they improve the soil. Worms feed on decaying organic matter and their faeces contain soil nutrients, such as nitrogen, phosphorus and potassium, in forms that are easier for plants to take up. Their tunnels also improve drainage and give a lighter, more airy structure to soil.

Ecologists may use the number of worms in a patch of earth as an indicator of whether soil has a good pH, sufficient organic matter and isn't too compacted. Gauging this in a standardised way involves digging multiple pits, which may be unappealing to home gardeners. I like to do an informal check every so often, by turning a few spades of soil onto a tarpaulin, even if just to practise my worm identification skills.

In healthy soil, the number of worms in a single pit that is 25 centimetres square and 10 cm deep could range from just a few to over 50, with the number varying with the season and moisture conditions, says Keiron Brown of the Earthworm Society of Britain.

Another way to assess your worm population is mustard sampling. Add 25 millilitres of mustard powder to 750 millilitres of water and shake well, then pour onto a small, bare patch of soil. Within about 10 minutes, any worms that come into contact with the liquid should be at the surface. The solution isn't harmful, but the worms do find it irritating, so, to be kind, you could wash them with water afterwards.

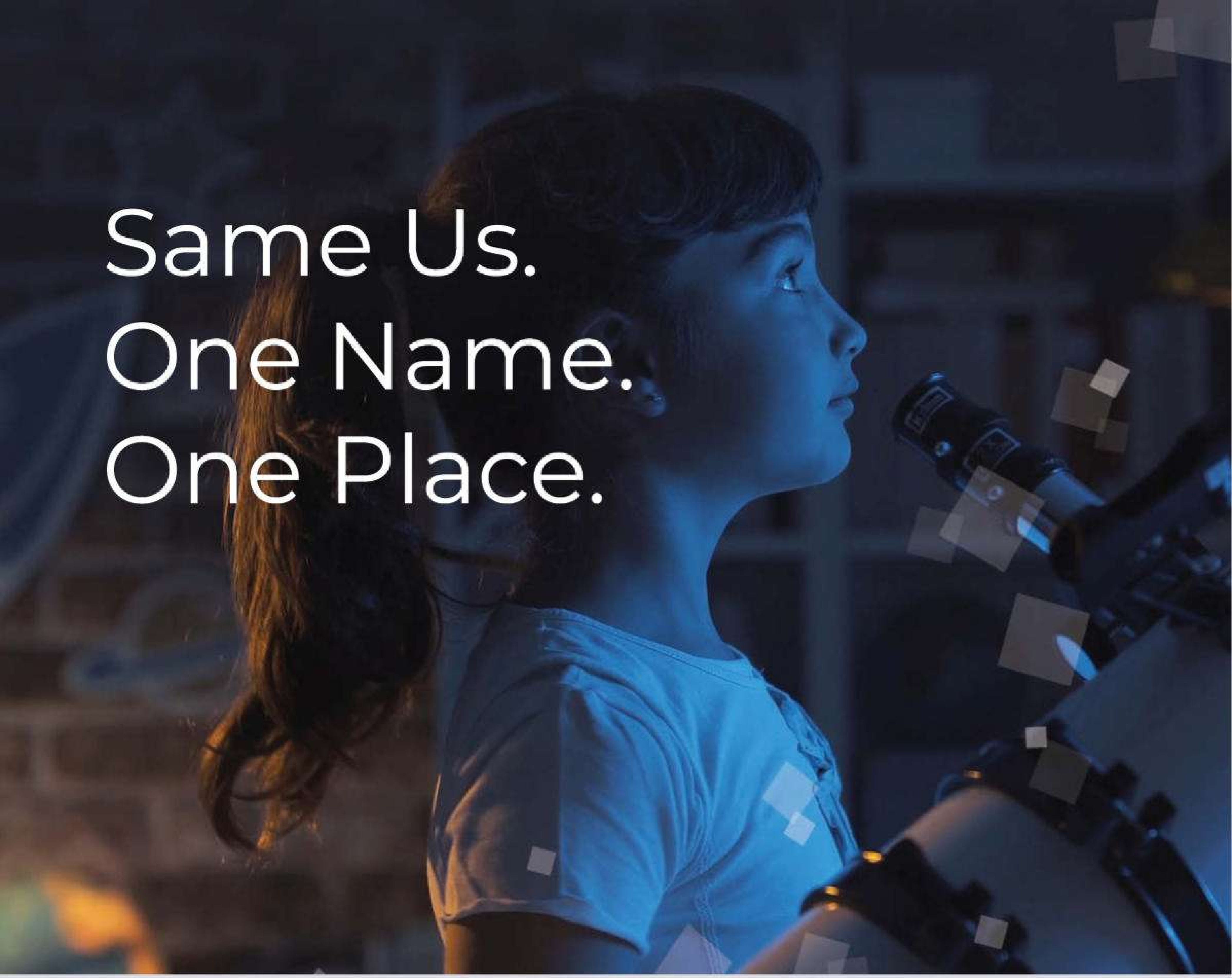
In temperate regions like the UK, there are three main types of worms. Epigeic earthworms usually live on the surface among dead leaves. They tend to be dark red, matchstick-sized and fast.

Endogeic earthworms are pale or greenish and live in the top 30 centimetres or so of the earth; they usually make horizontal burrows. Anecic earthworms are dark red and tend to be the longest; they make vertical burrows that can be 2 metres long and are invaluable for mixing up surface and deeper soil layers.

It is possible to buy worms to add to your garden, but it is best to entice them naturally by leaving any dead plant material, or leaf litter, on the soil and, if necessary, adding more organic matter, says Emma Sherlock at the Natural History Museum in London. This doesn't even need to be dug in – if you lay it on top of the soil, the worms will pull it down.

The ecosystem engineering powers of these animals are evident in the forests of Canada and the northern US, which today lack most species of earthworms because they died out there during the last glacial period. These forest floors have deep layers of decaying organic material. But, in areas where earthworms have been accidentally reintroduced, there is noticeable loss of these layers, which is bad for insects that make their home in this rich material. ▮

These articles are posted each week at **newscientist.com/maker**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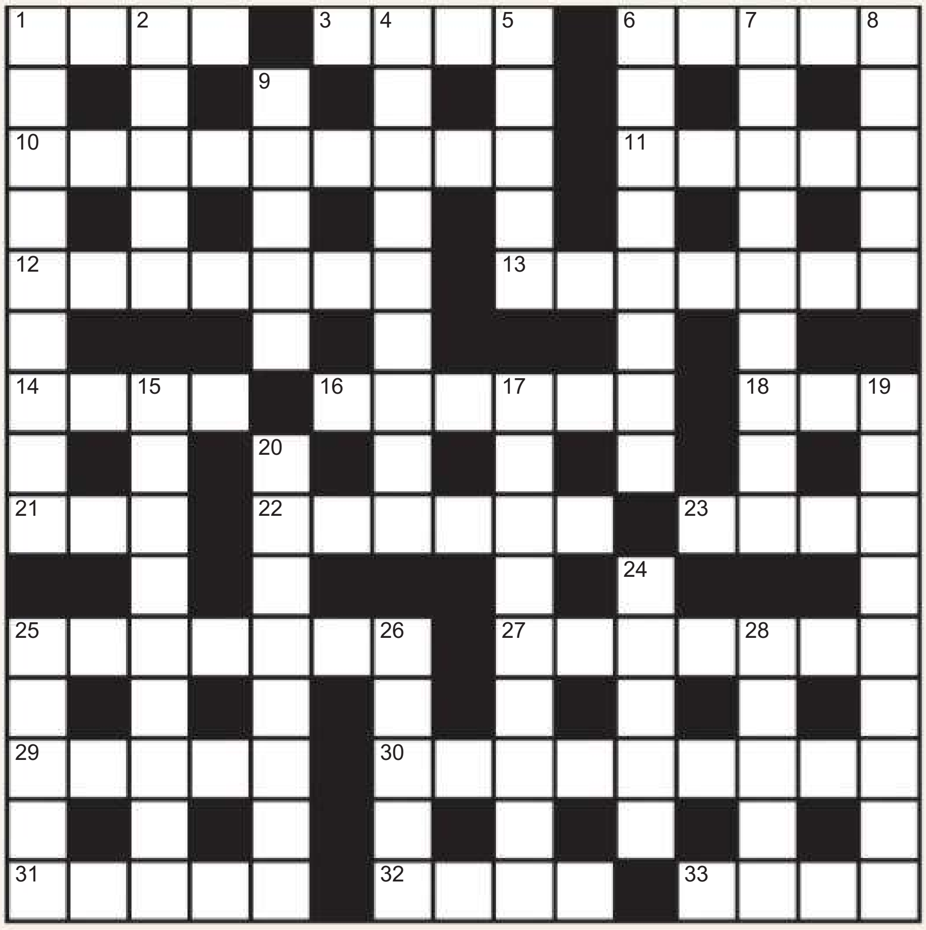
Quick crossword #128 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Fossil fuel (4)
3 Big ___, probable origin of the universe (4)
6 *P* (5)
10 Extinct ocean arthropod (9)
11 One-dimensional geometrical objects (5)
12 Flightless bird that might be chinstrap or emperor (7)
13 Smooth, durable coatings (7)
14 X or Y, typically (4)
16 Laboratory vessel (6)
18 Segment of a curve (3)
21 Extinct bird of New Zealand (3)
22 CH_3 (6)
23 Expected standard (4)
25 ___ memory, high-precision recall (7)
27 Twister (7)
29 Nerdy (5)
30 Protein found in muscle tissue (9)
31 Start again (5)
32 Oak, ash or elder, say (4)
33 Annular structure in the eye (4)

DOWN

1 Material enclosed by a cell membrane (9)
2 1979 sci-fi horror film (5)
4 Arrangement in parallel (9)
5 Diving water bird (5)
6 Disease caused by vitamin B3 deficiency (8)
7 Type of US motor home (9)
8 Shrubs with showy flowers and thorny stems (5)
9 Point of convergence; attention (5)
15 Network identification label (2,7)
17 Act of typing (9)
19 Combinations of elements (9)
20 Violet quartz (8)
24 Internet troublemaker (5)
25 Oak ___. A moth in the family Lasiocampidae (5)
26 Hyakutake or Hale-Bopp, perhaps (5)
28 Fossilised resin (5)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #192
set by Bethan Ackerley

1 What are the structures that make up the mycelium of a fungus called?

2 Anne McLaren's research led to the development of which medical technology?

3 Which of these insects gives birth to live young: aphids, tiger beetles or silkworms?

4 Where in the body would you find a coloboma?

5 Objects in the Kuiper belt that have a similar orbital period to that of Pluto are known as what?

Answers on page 55

Puzzle
set by Alison Kiddle
#212 Sound off

"Why isn't the sound working?" Mum muttered as she hit the mute key on the remote control.

"You've probably got the wrong remote, Mum," Sam said. "Remember, it's the long, thin one for the television, the wide one for the set-top box and the little one for the speakers. Which one did you mute?"

"I can't remember," said Mum, as she got her thinking cap on to try to fix things.

To get sound, all three remotes have to be unmuted. Mum came up with the most efficient system for cycling through the possible combinations of muting and unmuting, and got to work. What is the maximum number of presses needed if she wanted to be sure of getting the sound back?

Solution next week

How come dogs don't seem to get frozen paws from walking in the snow?

IMGORTHAND/GETTY IMAGES

This week's new questions

Fiddly fingers **Most violinists use their left hand for intricate fingerwork, so why is the right hand used for more complex key pressing on the piano?** ***Philip Welsby**, Edinburgh, UK*

Cold feet **If I go barefoot in snow, my feet soon hurt, yet my dog happily walks in freezing temperatures. What makes those paws so resistant to cold?** ***David Kohn**, Sarnia, Ontario, Canada*

Stirring it up

What is the most efficient way to stir to dissolve something in water: with circular motions, chaotic ones, fast or slow?

Karen Tansley
Milnthorpe, Cumbria, UK
My grandad, a keen gardener, swore by steady, figure-of-eight motions through the liquid, making sure whatever you were stirring with reached the bottom of the vessel (usually a watering can). Many of the garden feeds he used were granular and thorough mixing was important.

I have used this method since he taught it to me and it continues to work consistently. I even use it in my cups of tea.

@ScienceAmbass
via Twitter
Surely it depends on what solid is being dissolved and the concentration? A dash of sugar in tea needs just a quick swirl around, but Cup a Soup or hot chocolate requires specific excavation of the undissolved gloop around the edges at the bottom.

> **"Mixing liquids seems simple, but when it comes to tea, which is the best stirring method: figure-of-eight or straight?"**

Simon Dales
Oxford, UK
The best way to mix is to zigzag the stirrer. The objective is to expose as much surface area of the liquid to itself as possible.

A zigzag will stretch and fold the greatest volume. If you stir circularly, the liquid just follows the stick so can't mix much. You can observe this with sugar and water in a cup. Also, do this too fast and it "centrifuges" over the sides.

Zigzag movements only wiggle a small amount of the liquid at any one time, so reducing the sloshing. This is important when mixing liquids containing suspended particles such as paint, because the carrier liquid is so runny and sloshes at the first opportunity. Tahini is tricky to mix too: the oil sloshes easily, but the solids put up a fight. A long, thin stirrer is best to get the solids off the bottom of the vessel and rip them apart.

Mark Cargill
Alcester, Warwickshire, UK
Mixing liquids effectively seems simple, but when it comes to tea, which is the best method?

Mixing or agitating a liquid means creating vortices in it. These then homogenise the component parts of the liquids and any dissolved solids, such as sugar. Another element is rotational speed to keep the vortices going for longer, giving better mixing. A single stroke either up and down or side to side is quick but inefficient. With a figure-of-eight motion, the majority of the liquid is touched by the spoon, creating a rotation of the liquid plus those all-important vortices.

This method works up to a point, but with more viscous fluids, like paint, additional movements, such as an occasional diagonal stroke across the figure-of-eight, are needed to ensure efficient mixing.

Mark Wareing
Ashbourne, Derbyshire, UK
The first stage of successfully dissolving a fine powder in water is adding the powder in a way that minimises the formation of lumps. This is best done by using one hand to stir with a spoon in a circular motion at about 200 to 250 revolutions per minute to form a liquid vortex into which the powder is poured with the other hand.

The dispersed powder will initially circulate at the base of the container, reducing the solubility of undissolved powder. Therefore, at this stage, the stirring should be changed to a more turbulent system to mix the powder more evenly throughout the liquid and increase the rate at which it dissolves. Slower stirring with the spoon (at 60 to 70 cycles per minute) in a figure-of-eight pattern that touches the base of the container can be used.

Powder particle size is key. A relatively coarse powder such as caster sugar can easily be stirred in without lumping, hence the vortex stage is less important. In contrast, a fine powder such as icing sugar – which might be expected to dissolve more quickly – needs dispersing with the vortex method to reduce lumping.

Kim Heywood
via Facebook
Well, there is "efficient" and there is "less messy". I prefer not to slop stuff all over the table. It may be slower, but there is less mess to clear up afterwards.

[Ed – if you want to take stirring to the next level, the best way to mix two liquids is using two pentagon-shaped stirrers, moving in a jagged half circle, according to a 2022 study]

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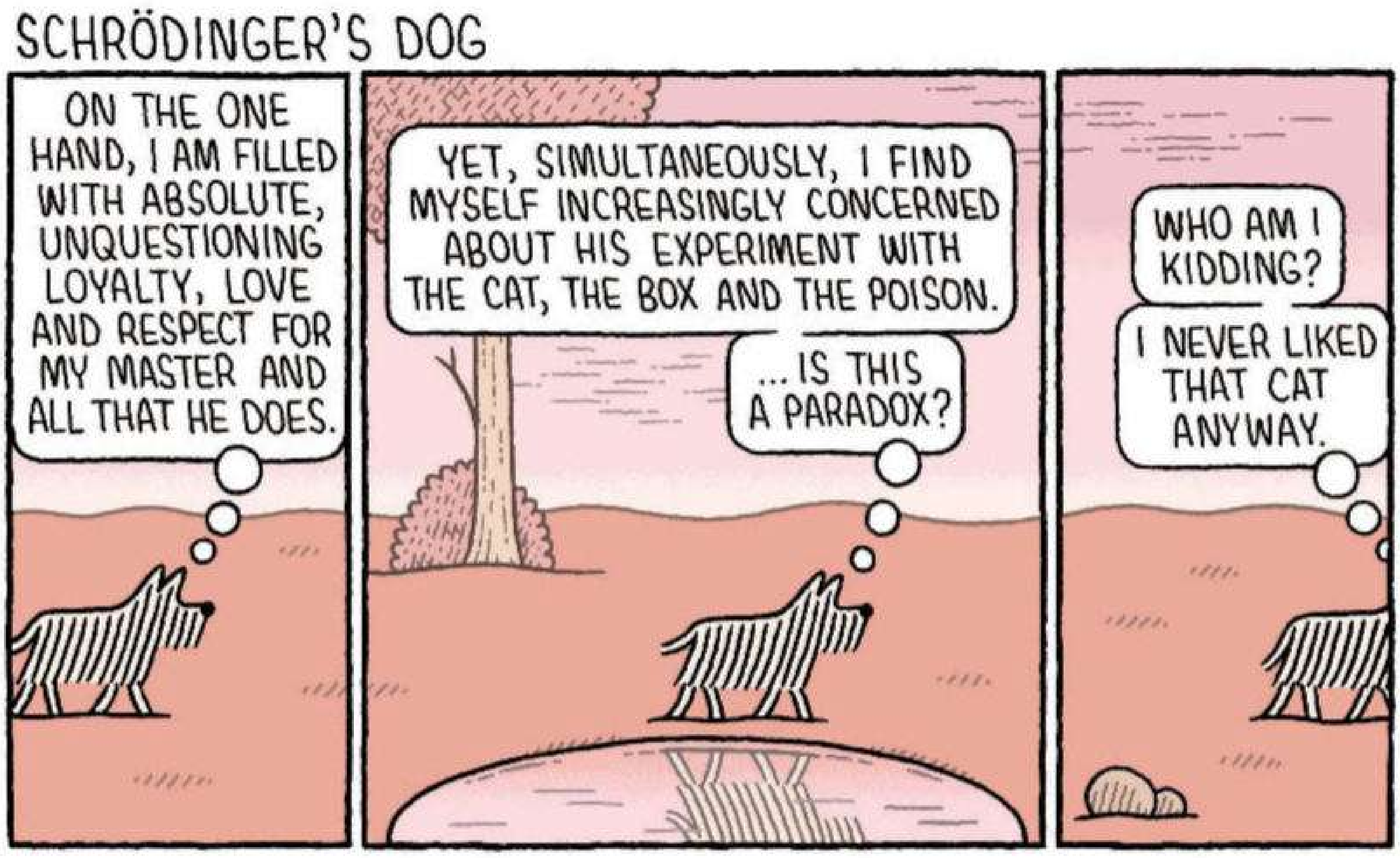
Cold noise

I live near Gatwick airport and am so used to the noise of planes that I rarely notice it. However, during a recent cold spell, the planes were a lot louder than usual. Why would this be?

Tom Gauld
for New Scientist


SCHRÖDINGER'S DOG
ON THE ONE HAND, I AM FILLED WITH ABSOLUTE, UNQUESTIONING LOYALTY, LOVE AND RESPECT FOR MY MASTER AND ALL THAT HE DOES.
YET, SIMULTANEOUSLY, I FIND MYSELF INCREASINGLY CONCERNED ABOUT HIS EXPERIMENT WITH THE CAT, THE BOX AND THE POISON.
... IS THIS A PARADOX?
WHO AM I KIDDING?
I NEVER LIKED THAT CAT ANYWAY.

Nick Baker
Colchester, Essex, UK

Cold weather is often associated with a temperature inversion where the temperature is lowest at ground level. Sound travels faster in warmer air and this leads to refraction, or a bending of the sound waves. According to the relative position of the source and the listener, this creates a focusing effect, making the noise louder on the ground.

Frank Dempsey
Pickering, Ontario, Canada

In my experience, louder, crisper noise from aircraft occurs when cold Arctic air linked with strong, high-pressure weather patterns moves overhead.

The very low humidity in the cold air allows better propagation of sound, since moisture attenuates its transmission. As well as this, the high pressure is associated with a sinking layer of dense, cold air, causing what is known as a subsidence inversion.

This acts as a low-level, horizontal boundary between cold air (in contact with the cold ground) and warmer air above it. The boundary reflects distant sounds to the observer, resulting in louder noise from an airport than normal, as sounds that would usually radiate upward as well as horizontally get reflected back down to ground level and seem louder.

These atmospheric conditions allow me to hear noise from distant trains and road traffic, as well as other sounds not normally heard in the absence of an inversion.

> **"Most birds are socially monogamous, but most are also sexually polygamous and have sex with multiple partners"**

Divided loyalty

Why is it that less than 5 per cent of mammal species are monogamous, compared with about 90 per cent of bird species? (continued)

Herman D'Hondt
Sydney, New South Wales, Australia

One thing that previous answers overlooked is that there is a difference between social and sexual monogamy.

Most birds are socially monogamous. This means that a pair will work together to raise the offspring. That pairing may last for a year or for a lifetime. The reason for this is that most bird species are born helpless and require a lot of care from both parents. That makes it evolutionarily beneficial for the parents to stay together.

But the vast majority of birds are sexually polygamous. In other words, both males and females have sex with multiple partners, all while building a nest with their social partner. The eggs they sit on can have multiple fathers.

While this had been noticed in a few bird species several decades ago, those were considered to be aberrations. It is only with modern DNA testing that the full extent has become obvious, and we now know that some 90 per cent of birds are sexually polygamous. ▮

Answers

Quick quiz #192
Answers

1 Hyphae
2 In vitro fertilisation, or IVF
3 Aphids
4 In the eye: it is a condition where there is a fissure in one of the structures of the eye, such as the iris
5 Plutinos

Cryptic crossword #104 *Answers*

ACROSS 7 Antihistamine, **8** Analemma, **9** Oboe, **10** Acetone, **12** Phone, **14** Ulnae, **16** Mantrap, **20** Relishes, **22** Gamma ray burst

DOWN 1 Anon, **2** Millet, **3** Siamang, **4** Stray, **5/19** Smooth newt, **6** Insomnia, **11** Calderas, **13** Walleye, **15** Asthma, **17** Tissue, **18** Crore, **21** Ease

#211 Cross purposes
Solution

Debbie crosses out 33, forcing Hoi to cross out 3, and Debbie wins with 51.

Fossil or beehive?

A new celebrity lookalike currently resides on a rock near Bhopal, India, drawing gossip as to whether it is (a) a fossil of a long-extinct creature known as *Dickinsonia tenuis*, or (b) the decayed remnants of a not very-old beehive.

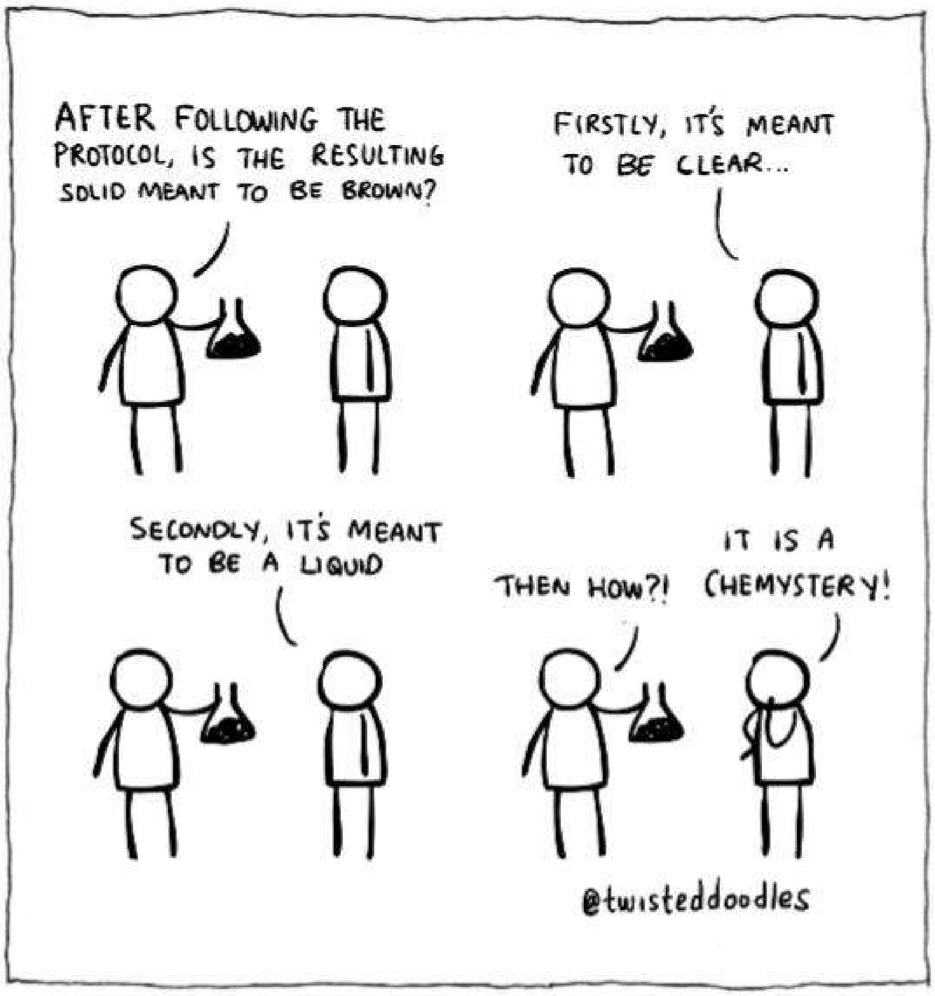
The journal *Gondwana Research* published an almost-licking-its-chops-in-delight rundown by scientists at the University of Rajasthan and the University of Florida. "[W]e note the structural similarities between '*Dickinsonia*' and honey and pollen stores of recently decayed bee nests," they write. Onwards they snipe, adding: "Moreover, we note the presence of myriad giant honeybee hives within the rock crevices that show remarkable similarities to the purported fossil of *Dickinsonia*".

The opposing case – that it is a glamorous fossil – was presented with equal but opposite happiness two years ago in the same journal. The it's-a-fossil team comprises researchers from the Geological Survey of India, the University of the Witwatersrand, South Africa, and institutions in the US. "*Dickinsonia* remains the most iconic and controversial of the dazzling array of Ediacaran fossils now known worldwide," they proclaimed. "Here we report three newly discovered fossils as the first record of the genus from India."

This kind of is-it-or-isn't-it confusion isn't unusual. It glares from the titles of two other reports: "The saga of the false fossil foram *Eozoon*" (published this year) and "Fossil lice (Insecta: Phthiraptera) reconsidered" (out in 2006).

And the snideness? That isn't unusual, either. Nor is it new. In 1934, the *Journal of the Washington Academy of Sciences* printed a report called "The supposed fossil ear of maize from Cuzco, Peru".

Twisteddoodles *for New Scientist*


AFTER FOLLOWING THE PROTOCOL, IS THE RESULTING SOLID MEANT TO BE BROWN?
FIRSTLY, IT'S MEANT TO BE CLEAR...
SECONDLY, IT'S MEANT TO BE A LIQUID
THEN HOW?!
IT IS A CHEMYSTERY!
@twisteddoodles

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Quantum black holes

Construct a list of every possible phrase that can be made by combining 17 words chosen at random from an English-language dictionary. One of those 17-word phrases will be: "It is thereby expected that all sufficiently advanced civilizations ultimately employ black holes in their quantum computers."

That exact phrase appears in a new study, "Black holes as tools for quantum computing by advanced extraterrestrial civilizations". Our own civilisation is already seeking advancement, as shown by several patent applications on file internationally. These are stuffed with ideas such as "Method for utilizing dimensional manipulation" – and quanta of confidence.

Music for unrelaxing

A project at the Max Planck Institute for Empirical Aesthetics in Frankfurt, Germany, is looking into the "effects of disliked music on psychophysiology". The research, as described by Julia Merrill, Taren-Ida Ackermann and Anna Czepiel, is both painstaking and painsgiving. They say that "participants listened to three self-selected disliked musical pieces which evoked highly unpleasant feelings".

They assess the changes evident in listeners' bodies: heart rate, skin conductance response and body temperature that each reflect "higher arousal" and reactions in three facial muscles. These are the levator labii associated with disgust, the corrugator supercilii that typically indicates anger and the zygomaticus major, which is linked to distress and grimacing. The reactions are most prominent, they say, when people listen to music of the "very unpleasant" variety.

Merrill, Ackermann and Czepiel do make it clear that this unpleasantness isn't the entirety of music's effects on all humans. They assure us that "previous research has shown the positive effects of music listening in response to one's favorite music".

Slime mould watch

A new variety of smartwatch is like Tamagotchi, but with real life to it – it is partly slime mould.

Tamagotchi, the electronic artificial pet that isn't much bigger than a wristwatch, entranced millions when it arrived on the market a quarter of a century ago. Its Japanese inventors, Akihiro Yokoi of Wiz Company and Aki Maita of Bandai Company, won the 1997 Ig Nobel prize for economics for "diverting millions of person-hours of work into the husbandry of virtual pets".

Now, Jasmine Lu and Pedro Lopes at the University of Chicago have created a smartwatch that is partly made of a slime mould (*Physarum*), a living entity that must be fed adequately and often enough or else the watch will stop running. As Lu and Lopes explain: "The slime mold grows to form an electrical wire... If the user does not care for the slime mold, it enters a dormant stage and is not conductive. The users can resuscitate it by resuming care." The care is fairly simple: give the slime mould a regular diet of water and oats.

Lu and Lopes say they tested their smartwatch by having humans wear it for nine to 14 days. "We found that participants felt a sense of responsibility, developed a reciprocal relationship, and experienced the organism's growth as a source of affect."

Tamagotchi itself now comes in the form of a smartwatch. The newest version of the old toy still "lives" via traditional electronics though. Its guts and nervous system depend not at all on slime mould, but on the combined power of an electrical battery and, like the Chicago smartwatch, the diligent attention (or not) of its human owner. ▮

Marc Abrahams

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ON GLASS

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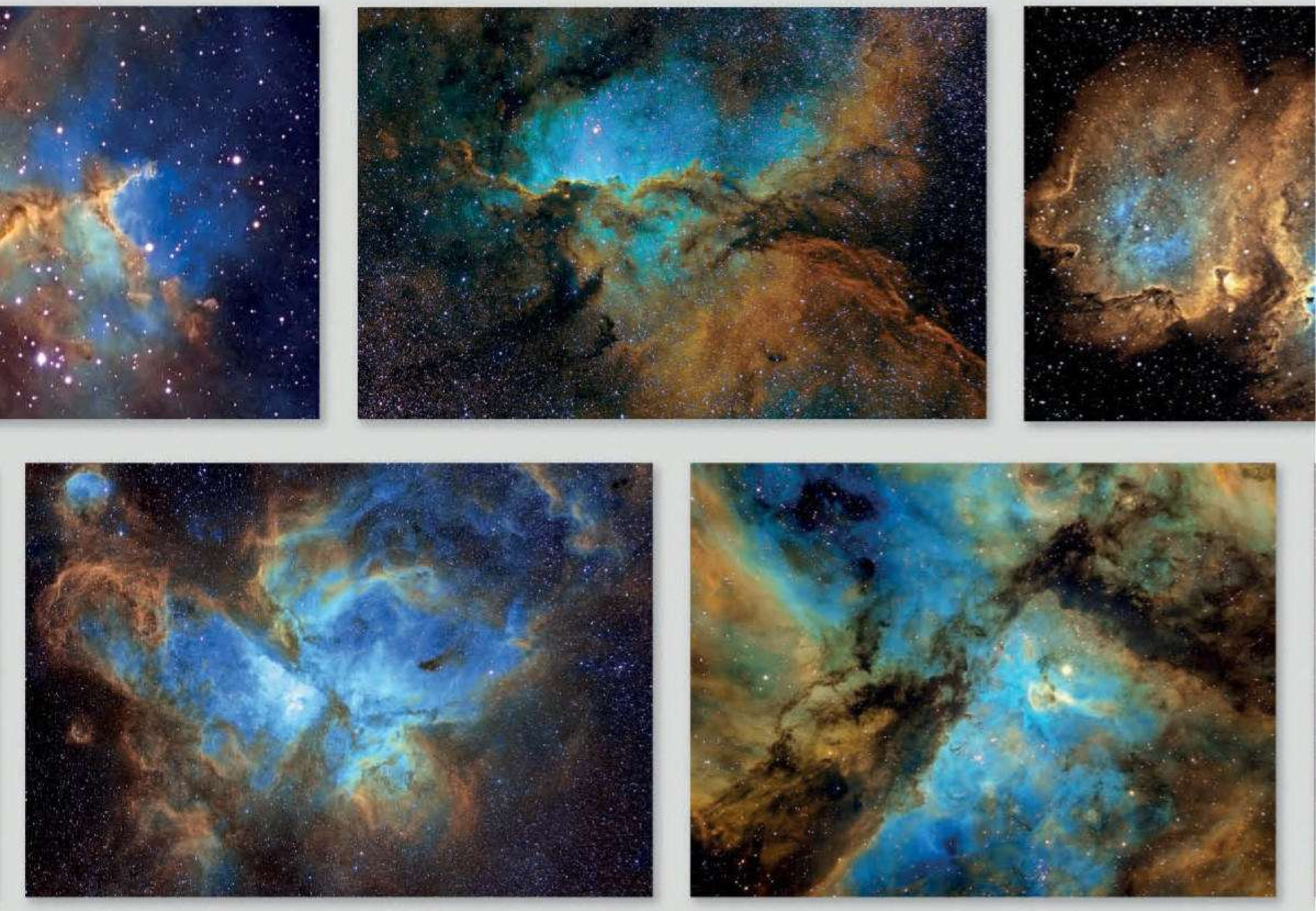

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